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NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, I

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SIXTEEN PLATES

Incidental to the preparation of a popular treatise on the orchids of the Philippines, the junior author has encountered several new species and varieties, descriptions of which seemed best to publish in a separate paper, together with notes on species that, though represented in other parts of the eastern Tropics, have not heretofore been recorded as natives of the Philippines. As a popular book is hardly the proper medium for the announcement of scientific discoveries, it is planned to publish in the Philippine Journal of Science a series of papers dealing with the new orchids now in hand and with the new or noteworthy species that are constantly being discovered through intensive exploration. Of the proposed series the present paper is the first number.

With very few exceptions, every Philippine orchid that has been illustrated in scientific publications in the last quarter of a century has been reconstructed from dead material in which the delicate structures of the flowers had been altered by desiccation. In the present series of papers it is proposed to issue plates that will portray the species discussed from living plants and will clearly represent diagnostic structures.

With the increasing interest that is being taken in the orchids of the Philippines by owners of gardens in the vicinity of Manila, there has developed a pressing need for critical studies of the horticultural forms which are commanding attention. The time has come when the study of living material should be undertaken more and more intensively, not only to solve horticultural problems, but to verify and amplify the results of the investigations through which our present knowledge of the Philippine orchid flora has been gained.

The types of the new species and varieties herein described have been deposited in the herbarium of the Bureau of Science and are represented by isotypes in the herbarium of Oakes Ames. Available isotypes will be distributed to American and European herbaria. All of our descriptions in the following pages have been prepared from living material with the exception of the one devoted to *Bulbophyllum ornatissimum*. All illustrations are by Mr. José M. Salazar, draftsman of the division of botany, Bureau of Science. The color terms used are mostly from Ridgway's Color Standards and Color Nomenclature (1912).

The present paper contains the descriptions of four species and one variety that appear to be new to science. Several previously described species are also included, together with notes and descriptions. *Haemaria* is included as a genus new to the Philippines.

The authors are under obligation to Dr. William H. Brown, Director of the Bureau of Science, who has given enthusiastic support and encouragement to the study of Philippine orchids.

Genus ADENOSTYLIS Blume

ADENOSTYLIS MERRILLII sp. nov. Plates 1, 3, and 7.

Affinis *Adenostylis luzonensis* Ames. Caules teretes, erecti, 10 ad 14 cm alti, 3 ad 4 mm in diametro, succulenti, supra folia longe villosi, pilis albidis. Folia prope medium caulium conferta, basibus petiolorum vaginantibus; lamina ovata ad ovato-lanceolata, acuta, plus minusve obliqua, 2.5 ad 4.5 cm longa, 1.4 ad 2.7 cm lata, membranacea. Bracteae inflorescentiae membranaceae, anguste lanceolatae, longe acute acuminatae, 8 ad 18 mm longae, sparsim pubescentes. Racemi 7.5 ad 8 cm longi, villosi. Flores in racemo laxo dispositi, albi, pedicello cum ovario dense villoso, cylindrico, anguste obovoideo, circiter 10 mm longo. Sepalum dorsale concavum, ovatum, circiter 9 mm longum, 5 mm latum, 5-nervium, extus villosum, petalis adha-

erens. Sepala lateralia extus pubescentia, oblongo-lanceolata, obtusa, circiter 9 mm longa, 3 mm lata, 3-nervia. Petala obliquissime oblanceolata, glabra, alba, obtusa, 3-nervia. Labellum cuneato-oblanceolatum, circiter 9.5 mm longum, 5 mm latum, concavum, prope apicem leviter trilobatum. Columna brevis, circiter 6 mm longa; rostellum erectum, bipartitum. Pollinia globosa, caudicula gracili affixa; glandula oblonga, alba.

Terrestrial, succulent herb. Stems terete, erect, sometimes with decumbent base, 10 to 14 cm high, 3 to 4 mm in diameter, long villose above the leaves, the hairs white. Leaves crowded above the middle of the stem with bases vaginate, the lamina ovate to ovate-lanceolate, acute, somewhat asymmetrical, 2.5 to 4.5 cm long, 1.4 to 2.7 cm wide, membranaceous, light green, reticulations distinct dark green. Bracts membranaceous, narrowly lanceolate, long and acutely acuminate, 8 to 18 mm long, sparsely pubescent. Racemes 7.5 to 8 cm long, villose. Flowers laxly arranged, white; the pedicel and ovary villose, cylindric; narrowly obovoid, about 10 mm long, grass green to kildare green. Dorsal sepal concave, ovate, buff-pink, about 9 mm long, 5 mm wide, villose on the outside, 5-nerved, the petals adhering. Lateral sepals white, buff-pink at the apex, the central nerve greenish, villose outside, oblong-lanceolate, obtuse, about 9 mm long, 3 mm wide, 3-nerved. Petals white, glabrous, obtuse, 3-nerved. Labellum white with a coral red line at the center and greenish at the base, cuneate-oblanceolate, about 9.5 mm long, 5 mm wide, concave, slightly trilobed near the apex. Column short, about 6 mm long; the rostellum erect, bipartite. Pollinia globose, the glands oblong, white.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78918 Quisumbing*, March 10, 1930. The living plants from Baguio, Mountain Province, were collected by Mrs. K. B. Day, who found them growing on moss-covered decayed logs and in mossy ground, at about 1,600 meters altitude.

This species is closely allied to *Adenostylis luzonensis* Ames, from which species it differs conspicuously in its subentire labellum and lower stature.

Genus HAEMARIA Lindley

HAEMARIA DISCOLOR Lindl. Plates 1 and 8.

Haemaria discolor LINDL., Gen. and Spec. Orch. (1840) 490; SCHLECHTER, Die Orchideen (1927) 118, *fig. 22.*

Goodyera discolor KER in Bot. Reg. (1818) *t. 271;* Lodd. Bot. Cab. (1817?) 148, Bot. Mag. (1819) *t. 2055.*

Ludisia discolor A. RICH. in Blume Fl. Jav. Orch. (1858) 95, *t. 42, fig. D.*
Ludisia furetii BLUME, Fl. Jav. Orch. (1858) 96, *t. 34, fig. 3.*
Ludisia odorata BLUME, Fl. Jav. Orch. (1858) 95, *t. 34, fig. 2.*

Stems succulent, naked, procumbent, glabrous below the leaves, brownish purple, ascending, 7 to 10 mm in diameter. Leaves alternate, approximate, ovate to elliptic, acute or apiculate, 3.5 to 7.5 cm long, 2 to 3.5 cm wide, the petioled base vaginate, upper surface velvety green to nearly black, with five prominent coral red lateral nerves (sometimes the venation reticulated; reticulations when present coral red), lower surface 3-nerved, the nerves vernonia-purple. Scape erect, terete, pale green, pubescent, 15 to 20 cm long; the inflorescence few-flowered; the bracts broadly lanceolate, shorter than the ovary. Flowers sessile, white except the sulphur yellow gynostemium, loosely arranged, odorless, 17 to 19 mm across. Ovary somewhat spirally twisted, white-pubescent, striped with green, about 15 mm long. Dorsal sepal cucullate, broadly ovate, obtuse, about 9 mm long, 7 mm wide. Lateral sepals slightly twisted, similar to the dorsal sepal. Petals lanceolate-linear, obtuse, adherent to the dorsal sepal. Labellum unguiculate, twisted, abruptly 2-lobed at the apex, lobes oblong, spreading. Gynostemium clavate, twisted. Anther horizontal, ovoid, acuminate, point slightly twisted; locules 2, parallel. Pollinia 2, clavate.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78902 Quisumbing*, February 20, 1930. Cultivated in Mrs. George Fairchild's gardens at Pasay, Rizal Province. Of Philippine origin, but the locality and province unknown. This orchid is often classified among the "jewel orchids," and is easily cultivated in pots, and reproduced by cuttings of the stem. It needs plenty of water. The plants flower during January and February.

This species has not heretofore been recorded from the Philippines, although it is known to be a native of the Malay Peninsula and China. According to the shape and color of the leaves several varieties were recognized.

Genus DENDROBIUM Swartz

DENDROBIUM CHAMELEON Amea. var. OVATILABIUM var. nov. Plates 1, 5, and 9.

A specie labelli lamina ovata solum differt.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 77227 Quisumbing*, August 12, 1929. The living specimens

collected in Floridablanca, Pampanga Province, hanging on trees, at medium altitudes. The leaves appear about December.

This variety differs conspicuously from *Dendrobium chameleon* Ames in its ovate labellum and in the color of its flowers.

Forma ALBA forma nov.

Species similis differt floribus colorem.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 77227a Quisumbing,* August 16, 1929. Living plants from Floridablanca, Pampanga Province, hanging on trees, at medium altitudes.

This form is identical with the species in every respect except that the flowers are pure white with a cream-colored spur.

DENDROBIUM MIYASAKII sp. nov. Plates 1, 4, and 9.

Species *D. victoriae-reginae* Loher affinis, floribus multo majoribus differt. Caules sulcati, pauci et gracile, superne pauciramosi, usque ad 75 cm alti, 4 mm in diametro, internodia plerumque 1 ad 4.5 cm longa. Folia lineari-lanceolata, acuta, 6 ad 8.5 cm longa, 0.5 ad 1.1 cm lata, subcoriacea, in basi amplectentia. Pedunculus circiter 5 mm longus. Flores singuli, 4 ad 5.5 cm longi, 4 ad 5.5 cm lati; ovarium cum pedicello tenue, 2.5 ad 3 cm longum. Sepalum dorsale oblongo-lanceolatum, obtusum, 2.3 ad 2.5 cm longum, 0.9 ad 1.1 cm latum. Sepala lateralia triangulari-lanceolata, obtusa, in mentum obtusum producta, 4.2 ad 4.5 cm longa, 1.3 ad 1.4 cm lata; mentum 2.1 ad 2.4 cm longum. Petala elliptica vel elliptico-ovata, obtusa vel rotundata vel leviter retusa, 2.1 ad 3 cm longa, 1.4 ad 1.8 cm lata, margine anteriore minutissime crenulato. Labellum simplex, breviter unguiculatum, e basi cuneata, obovatum vel oblanceolatum, 3.5 ad 4.3 cm longum, antice dilatatum, 1.6 ad 2.5 cm latum, in apice retusum. Gynostemium lobulatum.

Stems erect, sulcate, few and slender, up to 75 cm high, 4 mm in diameter, dark purple; branches few, rooting at the nodes, greenish, about 2 mm in diameter. Leaves linear-lanceolate, acute, 6 to 8.5 cm long, 0.5 to 1.1 cm wide, the uppermost ones about 2.5 cm long, subcoriaceous when dry, clasping at base. Peduncles about 5 mm long. Flowers solitary at the end of the branches, pendulous, not fragrant, 4 to 5.5 cm long, 4 to 5.5 cm across; pedicellate ovary slender, 2.5 to 3 cm long. Sepals white, suffused with mallow pink half way to the apex. Dorsal sepal oblong-lanceolate, obtuse, 2.3 to 2.5 cm long, 0.9 to 1.1 cm wide. Lateral sepals triangular-lanceolate, obtuse, with the spur

4.2 to 4.5 cm long, 1.3 to 1.4 cm wide; spur 2.1 to 2.4 cm long, white with obtuse grass green tip. Petals elliptic to elliptic-ovate, obtuse, rounded or somewhat retuse, 2.1 to 3 cm long, 1.4 to 1.8 cm wide, the anterior margins minutely crenulate, mallow pink to light mallow purple, white at the base. Labellum simple, obovate to oblanceolate, somewhat unguiculate, narrowed at the cuneate base, 3.5 to 4.3 cm long, 1.6 to 2.5 cm wide, the apex retuse, the expanded portion minutely crenulate, mallow purple, with three true purple lines extending on the narrowed portion to the base. Gynostemium lobulate, white, with purple markings on the margins.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78823 Quisumbing*, December 29, 1929. The living specimens collected from Pampanga Province, on rocks on the hills back of Floridablanca. Flowers during December to March.

A previous collection referable to this species, was made in Zambales Province, on rocks of Mount Tapolao at 2,000 feet altitude, November-December, 1924, *Bur. Sci. 44715 Ramos and Edaño*. The flowers were described by the collectors as being pink and white.

A species closely allied to *Dendrobium victoriae-reginae* Loher but differing radically in its habit and in its much larger flowers. The species is dedicated to Mr. S. Miyasaki, enthusiastic orchid grower in Manila, in whose garden the junior author has enjoyed every facility for the study of orchids and to whom he is under many obligations.

Genus ERIA Lindley

ERIA APOROIDES Lindl.

Dendrobium aporoides (Lindl.) Merr. MERR., Sp. Blancoanae (1918) 113, Enum. Philip. Fl. Pl. 1 (1924) 345.

Upon critical examination of numerous living Philippine plants of this species it has been found that the pollen masses are eight in number. The species is therefore indubitably a member of the genus *Eria* as J. J. Smith has indicated, as a result of additional research, in Bull. Jard. Bot. Bait. Ser. 3, 8. Liv. 1 (1926) 49.

ERIA LONGISSIMA sp. nov. § Cylindrolobus. Plates 1, 5, 10, and 11.

Habitu *E. perspicabili* Ames similis. Caulis simplex, ad basi teres, superne leviter complanatus, foliosus, 50 ad 100 cm longus, 0.8 ad 1.3 cm in diametro, internodii 2 ad 3.5 cm longis. Folia lineari-lanceolata, glabra, in sicco subcoriacea, nervosa, attenuata, 9.5 ad 20 cm longa, 2 ad 4 cm lata, in apice inaequaliter

bilobulata, basi vaginanti. Inflorescentiae oppositifoliae, 2- ad 4-florae, cum pedunculo circiter 4.5 cm longae; pedunculus usque ad racemum brevis, circiter 1.5 cm longus. Bractae 5 vel 6, conspicuae, glabrae, oblongo-lanceolatae vel lanceolatae, subacutae, 19 ad 21 mm longae, 5 ad 7 mm latae, in basi cordatis. Flores circiter 1.5 cm longi; pedicellus glaber, cum ovario, 1.3 ad 2 cm longus. Sepalum dorsale oblongum, obtusum, circiter 15 mm longum, 6 mm latum. Sepala lateralia triangulari-lanceolata, obtusa, circiter 15 mm longa, 6.5 mm lata, subfalcata, mentum brevem formantia; mentum circiter 6 mm longum. Petala leviter oblique-oblonga, valde obtusa, circiter 13 mm longa, 5 mm lata, membranacea, marginibus aliquando inaequaliter et leviter irregularibus. Labellum in circuitu suborbiculare, prope apicem 3-lobatum, circiter 9 mm longum, in basi breviter unguiculatum; lobi laterales breves, obtusi, circiter 1.5 mm longi; lobus medius late ovatus, obtusus, incrassatus, circiter 3 mm longus, margine subcrispato. Discus per medium carinis 3 humilibus percursus quae in lobo medio confluunt, carinis in basi utrinque dilatatis. Gynostemium circiter 8 mm longum, crassum, apice bilobatum, in pedem 3 mm longum productum.

An epiphyte with much the habit of *Eria perspicabilis* Ames. Stems simple, terete at the base, somewhat complanate above, foliose, 50 to 100 cm long, 0.8 to 1.3 cm in diameter; the internodes 2 to 3.5 cm long. Leaves linear-lanceolate, glabrous, somewhat firm in living condition, subcoriaceous when dry, nervose, light green, 9.5 to 20 cm long, 2 to 4 cm wide, narrowed to the unequally bilobed apex, the base clasping and sheathed. Racemes opposite the leaves, 2- to 4-flowered, with the peduncle about 4.5 cm long; the peduncles up to the raceme about 1.5 cm long. Bracts citron yellow, 5 or 6, conspicuous, glabrous, oblong-lanceolate to lanceolate, obtuse, 19 to 21 mm long, 5 to 7 mm wide, the apex minutely apiculate, the base cordate. Flowers fragrant, recalling the odor of *Jasminum sambac*, conspicuous, white, about 1.5 cm long; the pedicels with the ovary glabrous, citron yellow, 1.3 to 2 cm long. Sepals and petals pure white with bases naphthalene yellow, the spur naphthalene yellow. Dorsal sepal oblong, obtuse, about 15 mm long, 6 mm wide. Lateral sepals triangular-lanceolate, obtuse, about 15 mm long, 6.5 mm wide, subfalcate, forming a rather short spur, which is about 6 mm long. Petals obliquely oblong or elliptic-oblong, broadly obtuse, about 13 mm long, 5 mm wide, membranaceous, margins sometimes slightly irregular. Labellum white without, cream-buff within, suborbicular in outline, 3-lobed near

the apex, about 9 mm long, shortly unguiculate at base; lateral lobes short, obtuse, about 1.5 mm long; middle lobe broadly ovate, obtuse, about 3 mm long, rather thickened, margin subcrispate. Disc traversed through the middle by 3 low keels which come together on the middle lobe, keels at base on each side dilated. Gynostemium about 8 mm long, rather thick, the apex bilobed, the foot about 3 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 77242 Quisumbing*, June 1, 1929. The living plants were collected from the mossy forests of Mount Maquiling, Laguna Province, Luzon.

This species has the appearance of *Eria perspicabilis* Ames but is most closely allied to *E. brachystachya* Reichb. f. and to *E. albolutea* Rolfe. It is larger throughout than *E. brachystachya* with a rather different lip. It has much larger leaves, fewer-flowered racemes, and apparently wider perianth parts than *E. albolutea* Rolfe.

Genus BULBOPHYLLUM Thouars

BULBOPHYLLUM BIFLORUM Teijsm. and Binn. Plates 2 and 12.

Bulbophyllum biflorum TEIJSM. and BINN., Nat. Tijdschr. Ned. Ind. 3 (1855) 397; J. J. SM., Fl. Buitenz. 6 (Orch. Jav.) (1905) 469, Fig.-Atlas (1911) *fig. 359;* MIQ., Fl. Ind. Bat. 3 (1859) 647; REICHB. f., Walp. Ann. Bot. Syst. 6 (1861) 262; NAVES, Novis. App. (1882) 234; AMES in Merr. Enum. Philip. Fl. Pl. 1 (1925) 390.

Cirrhopetalum biflorum J. J. SM., Ic. Bog. 2 (1903) 104, *t. 120 B;* SCHLTR., Die Orchideen (1927) 329; Sanders' Orchid Guide (1927) 113.

Phyllorchis biflora OK., Rev. Gen Pl. 2 (1891) 677.

Epiphyte. Pseudobulbs 4-angled, one-leafed, ovoid, 2.5 to 3.5 cm long, 1.3 to 2 cm wide. Leaves at the top of the pseudobulbs, oblong-elliptic, 7 to 11 cm long, 2.5 to 3.5 cm wide. Inflorescence arising from the base of the pseudobulb, two-flowered; the peduncle slender, about 8 cm long; bracts membranaceous. Flowers about 9.5 cm long, emit a peculiar odor, pedicel and ovary slender, about 1.5 cm long. Dorsal sepal elliptic with a filament, about 2.5 cm long, very pale pink to almost white striped and spotted with pomegranate purple, 5-nerved. Lateral sepals joined or free, greatly elongated into very slender filaments, 7.5 to 8 cm long, 0.6 to 0.65 mm wide, very pale pink to almost white, spotted and striped with pomegranate purple, the tips tawny purple, 5-nerved. Petals much smaller, about 6 mm long, 3.5 mm wide, with a minute apicule about 1 mm in length, 3-nerved. Labellum oblong-ovate, fleshy, recurved, yel-

lowish brown, spotted with dark purple, about 5 mm long. Column somewhat fleshy, about 4 mm long, with the foot about 7 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78844 Quisumbing*, May 28, 1929. Living plants collected from Mount Banahao, Tayabas Province, growing on tree trunks at medium altitudes. A native of Java.

A very interesting species characterized by its two-flowered inflorescences. Originally known from Java, now for the first time authentically reported from the Philippines.

BULBOPHYLLUM EMILIORUM sp. nov. Plates 2, 6, and 13.

Affine *B. copelandii* Ames. Rhizoma repens, circiter 5 mm in diametro, radicibus numerosis simplicibus vel ramosis. Pseudobulbi 1.8 ad 2 cm longi, 1.2 ad 1.3 cm in diametro, monophylli, 8 ad 10 cm distantes. Folia elliptico-oblonga, obtusa, coriacea, rigida, 19 ad 21 cm longa, 6 ad 6.5 cm lata. Pedunculus gracilis, circiter 1 cm longus, florem singulum speciosum gerens, pedicello cum ovario 4.5 ad 5.5 cm longo, bracteis membranaceis. Sepalum dorsale oblongo-lanceolatum, tenuiter acute acuminatum, circiter 3.5 cm longum, 1.2 cm latum. Sepala lateralia sigmoideo-lanceolata, tenuiter acuminata, circiter 3.2 cm longa, prope basim 1.3 cm lata. Petala anguste lanceolata, acuminata apice recurvata, fastigiata, circiter 3 cm longa, 0.8 cm lata. Labellum cum pede elongato columnae articulatum, recurvatum, carnosum; lobi laterales breves, rotundati, obtusi, circiter 2 mm longi; lobus medius lineari-lanceolatus, acutus, circiter 8 mm longus, 3.5 mm latus, recurvatus, carnosus, rigidus. Columna crassa, brevissima, erecta, circiter 4 mm longa et lata, basis lata in pedem 9 mm longum transiens.

Rhizomes creeping, about 5 mm in diameter; roots numerous, simple or branching. Pseudobulbs 1.8 to 2 cm long, 1.2 to 1.3 cm in diameter, monophyllous, 8 to 10 cm distant. Leaves elliptic-oblong, obtuse, coriaceous when dry, rather thick when fresh, rigid, 19 to 21 cm long, 6 to 6.5 cm wide. Inflorescence one-flowered; the peduncles slender, rather short, about 1 cm long; pedicel and ovary 4.5 to 5.5 cm long; bracts membranaceous. Dorsal sepal oblong-lanceolate, slenderly and acutely acuminate, about 3.5 cm long, 1.2 cm wide. Lateral sepals sigmoid-lanceolate, slenderly acuminate, about 3.2 cm long, 1.3 cm wide near the base. Petals narrowly lanceolate, acuminate with recurved apex, fastigiate, about 3 cm long, 0.8 cm wide. Lip hanging on a very slender foot; lateral lobes short, rounded,

spreading, obtuse, about 2 mm long; middle lobe linear-lanceolate, acute, about 8 mm long, 3.5 mm wide, recurved, fleshy, rigid. Column thickened, very short, erect, about 4 mm long and broad, the foot about 9 mm long. Pollinia triangular.

MINDANAO, Agusan Province, Butuan, Barrio Guadalupe, *Emilio Quisumbing, s. n., July 1929*, on tree trunks in thick forests at low altitudes. Flowers fragrant, recalling the odor of *Dendrobium anosmum* Lindl. Peduncles pinard yellow; lateral sepals and dorsal sepal wax yellow on the back, mottled with amaranth purple, the apices suffused with bordeaux; the bases of the dorsal sepal and petals suffused with amaranth purple within; the petals white on the back; lip bordeaux half-way to the apex and pinard yellow at the base; column and foot pinard yellow.

A species closely allied to *Bulbophyllum copelandii* Ames, differing in its much larger leaves and flowers and in its differently shaped dorsal and lateral sepals, petals and labellum. The species is dedicated to Mr. Emilio Quisumbing, civil engineer, who collected the living specimens.

BULBOPHYLLUM ANTENNIFERUM (Lindl.) Reichb. f. Plates 2 and 14.

Bulbophyllum antenniferum (Lindl.) Reichb. f. in (Ames) Merr. Enum. Philip. Fl. Pl. 1 (1925) 379.

Rhizome creeping, 4 to 5 mm in diameter. Pseudobulbs one-leafed, 4-angled, ovoid, 1.5 to 2.5 cm long, 1.3 to 1.6 cm in diameter, 1 to 2 cm distant. Leaves rather thick, oblanceolate, elliptic-lanceolate or oblong-oblanceolate, rounded at the apex, subretuse, 8 to 15 cm long, 3 to 4.8 cm wide. Inflorescences usually one-flowered, very seldom two-flowered, conspicuous; peduncles 9 to 13.5 cm long, green. Bracts sheathing, about 1.5 cm long. Pedicel and ovary 4 to 5 cm long. Dorsal sepal large, ovate-lanceolate to lanceolate, somewhat fleshy, 9-nerved, carinate, 4 to 6.5 cm long, 1.2 to 1.5 cm wide, corinthian purple on the back, reed yellow in front, suffused with some corinthian purple and spotted with transparent white. Lateral sepals connate, smaller than the dorsal sepal, individually 6- or 7-nerved, narrowly lanceolate, falcate, 3.5 to 5 cm long, 0.7 to 0.8 cm wide, citron green and corinthian purple at the base. Petals very much smaller than the sepals, ovate-lanceolate, with prolonged filiform apex, terminating in a pyriform tip, pale grass green, striped with light purple, 3-nerved, 12 to 13 mm long, 2.5 to 3.5 mm wide. Lip recurved, fleshy, pilose above, corinthian purple at the apex, 4 to 5 mm long. Gynostemium 3-toothed, about 3 mm long. Pollinia yellow, somewhat ovoid.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78847 Quisumbing*, September 24, 1929, living plants collected in Paete, Laguna Province; *Bur. Sci. 78845 Quisumbing*, December 11, 1929, living plants collected on Mount Mariveles, Bataan Province, creeping on tree trunks at low and medium altitudes.

BULBOPHYLLUM EBRACTEOLATUM Kränzl. **Plates 2, 3, and 15.**

Bulbophyllum ebracteolatum KRÄNZL. in Ann. k. k. Nat. Hofmus. Wien 30 (1916) 58; AMES in Merr. Enum. Philip. Fl. Pl. 1 (1925) 382.

Rhizomes creeping, 3.5 to 7 mm in diameter. Pseudobulbs one-leafed, remote, 4- or 5-angled, ovoid to ovoid-lanceolate, 3 to 4.5 cm long, 1.4 to 2 cm in diameter, 1.4 to 2 cm distant; the base of the pseudobulbs covered by two brown, membranaceous sheaths, 1.5 to 3.2 cm long, the lower one smaller. Leaves linear, 10 to 17 cm long, 1.7 to 2.5 cm wide, narrowed at both ends, the apex acute; petioles very short. Scape arising at the base of the pseudobulb, 5 to 8.5 cm long including the peduncles; the peduncles white flushed with some purple, pubescent with minute white hairs, 2 to 2.5 cm long, fleshy; the rachis fleshy, white, flushed with some purple, pubescent with minute white hairs, 5 to 6 mm in diameter. Basal sheaths two, brown, membranaceous, 8 to 10 mm long. Flowers odorless, minutely pubescent, 4.5 to 5 mm long, spirally arranged on the rachis, rather remote, the side view giving the appearance of a snake's head. Floral bracts covering the pedicels and ovaries cucullate, greenish or light purple, ovate, obtuse, 3 to 4 mm long. Pedicel and ovary very short, 1 to 2 mm long, purple, pubescent. Dorsal sepal cucullate, ovate, obtuse, 4 to 5 mm long, 2.5 to 3 mm wide, marguerite yellow to almost white, 3-nerved, the nerves pansy purple. Lateral sepals cucullate, connate, oblong, broadly obtuse to rounded, 4.5 to 5.5 mm long, 3 to 4 mm wide, marguerite yellow to almost white, 7-nerved, the nerves pansy purple. Petals very much smaller than the sepals, lanceolate, acutely acuminate, about 2 mm long, 1 mm wide, marguerite yellow to almost white, 1-nerved, the central nerve and smooth margins pansy purple. Lip fleshy, 3-lobed, about 3.5 mm long; the lateral lobes rather insconspicuous, minute, obtuse, up to 0.5 mm long, madder brown; the middle lobe oblong, rounded, lime green, pompeian red at the base. Foot slender, somewhat flattened, flesh color, about 1 mm long. Column white, fleshy, about 2 mm long, the apex pubescent, the arms two, bicuspidate. Pollinia ivory yellow, suborbicular.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78924 Quisumbing*, February 27, 1930. Living plants collected

from Mount Banahao, Laguna Province, as an epiphyte, at medium altitudes.

A species manifestly belonging in the group with *Bulbophyllum crassifolium* (Blume) J. J. Sm. and strongly characterized by its fleshy rachis, subsessile flowers, smooth-margined petals and by the bicuspidate wings or arms of the apex of the column.

BULBOPHYLLUM ORNATISSIMUM (Reichb. f.) J. J. Sm. Plate 16.

Bulbophyllum ornatissimum (Reichb. f.) J. J. SM. in Bull. Jard. Bot. Buit. 8 (1912) 26.

Cirrhopetalum ornatissimum REICHB. f. in Gard. Chron. 2 (1882) 424; KING and PRANTL, Ann. Roy. Bot. Gard. Calcutta 8 (1898) 95, *t. 133;* WARNER, Orch. Album 8 (1889) *t. 369;* HOOK. f., Fl. Brit. Ind. 5 (1890) 773; Sanders' Orch. Guide (1927) 116; SCHLECHT., Die Orchideen (1927) 331.

Creeping, the rhizome 2 to 2.5 mm in diameter. Pseudobulbs ellipsoid, 1.5 to 2 cm long, 2 to 3 cm distant, olive-green, bearing a single leathery leaf. Leaves oblong or elliptic-oblong, sessile, apex obtuse and slightly notched, 6 to 8 cm long, 1.3 to 1.7 cm wide. Scape one-flowered, arising from the base of the pseudobulb; peduncle about 10.5 cm long, bearing 2 or 3 sheathing bracts. Flower about 14 cm long. Pedicel and ovary about 13 mm long. Floral bract membranaceous, lanceolate, about 8.5 mm long. Dorsal sepal ovate, about 2 cm long, erect, 3-nerved, the apex extended into a long drooping filiform appendage bearing hairs on its edges in its lower part and paleæ in its apical portion. Lateral sepals lanceolate with filiform tails, about 12 cm long, the tips twisted, free at the base and apex, otherwise coherent. Petals lanceolate, falcate, about 1.5 cm long, 1-nerved, with filiform palea-bearing apices like the dorsal sepal. Lip oblong, obtuse, recurved from a very concave base, with three raised lines. Column broad with hooked decurved apical teeth which are dentate at their bases; foot curved, tapering. Anther pubescent in front. Pollinia attached to a viscous, oblong, compressed disc.

LUZON, Zambales Province, Mount Marayap, *Bur. Sci. 44806 Ramos and Edaño,* December 12, 1924, on tree trunks in the mossy forests, altitude about 400 meters. The flowers pale yellowish green with purple-brown markings, the paleæ and lip are crimson purple.

A unique species characterized by its greatly elongated lateral sepals and paleæ on the dorsal sepal and petals. A species otherwise known only from Assam and Sikkim.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Dendrobium chameleon* Ames var. *ovatilabium* var. nov., side and front views of flower, × 1.
2. *Dendrobium chameleon* Ames forma *alba* forma nov., front view of flower, × 1.
3. *Haemaria discolor* Lindl., side view of flower, × 1.
4. *Haemaria discolor* Lindl., front view of flower, × 1.
5. *Dendrobium miyasakii* sp. nov., front view of flower, × 1.
6. *Dendrobium miyasakii* sp. nov., side view of flower, × 1.
7. *Adenostylis merrillii* sp. nov., side view of flower, × 2.
8. *Adenostylis merrillii* sp. nov., front view of flower, × 2.
9. *Eria longissima* sp. nov., portion of a flowering stem showing typical clusters of flowers, × 1.

PLATE 2

FIG. 1. *Bulbophyllum emiliorum* sp. nov., front view of flower, × 1.
2. *Bulbophyllum emiliorum* sp. nov., side view of flower, × 1.
3. *Bulbophyllum ebracteolatum* Kränzl., side view of flower, × 4.
4. *Bulbophyllum ebracteolatum* Kränzl., front view of flower, × 4.
5. *Bulbophyllum biflorum* Teijsm. and Binn., two flowers, × 1.
6. *Bulbophyllum antenniferum* (Lindl.) Reichb. f., front view of flower, × 1.
7. *Bulbophyllum antenniferum* (Lindl.) Reichb. f., side view of flower, × 1.

PLATE 3

ADENOSTYLIS MERRILLII SP. NOV.

FIG. 1. Petal, × 6.
2. Dorsal sepal and petals attached from back, × 6.
3. Lateral sepal from back, × 6.
4. Labellum, × 6.
5. Side view of column, × 6.

BULBOPHYLLUM EBRACTEOLATUM KRÄNZL.

FIG. 6. Habit, × 0.5.
7. Dorsal sepal, × 6.5.
8. Petal, × 6.5.
9. Lower view of confluent lateral sepals, × 6.5.
10. Upper view of confluent lateral sepals, column, and lip, × 6.5.
11. Upper view of column, × 7.5.
12. Side view of column, × 7.5.
13. Pollinia, × 25.
14. Labellum, × 7.5.

PLATE 4

DENDROBIUM MIYASAKII SP. NOV.

FIG. 1. Stem and branch, showing typical leaves, × 0.5.
2. Dorsal sepal, × 1.
3. Lateral sepal and spur, × 1.
4. Petal, × 1.
5. Labellum, × 1.
6. Front view of column, × 1.
7. Front and back views of anther cap, × 3.
8. Pollinia, × 5.

PLATE 5

DENDROBIUM CHAMELEON AMES VAR. OVATILABIUM VAR. NOV.

FIG. 1. Branch, × 0.5.
2. Portion of stems and flowers, approximately × 0.5.
3. Dorsal sepal, × 1.
4. Lateral sepal and spur, × 1.
5. Petal, × 1.
6. Labellum, × 1.
7. Front view of column, × 2.5.
8. Back view of anther cap, × 2.5.

ERIA LONGISSIMA SP. NOV.

9. Back and front views of a bract, × 1.
10. Dorsal sepal, × 1.
11. Lateral sepal, × 1.
12. Petal, × 1.
13. Side view of column, lip, pedicel, and ovary, × 2.
14. Front view of labellum, × 2.
15. Front view of column, × 2.
16. Back and front views of anther cap, × 7.

PLATE 6. BULBOPHYLLUM EMILIORUM SP. NOV.

FIG. 1. Habit, × 0.5.
2. Column, foot, and attachment of lateral sepal, × 3.25.
3. Petal, × 1.625.
4. Labellum from side, × 3.25.
5. Dorsal sepal, × 1.625.
6. Lateral sepal, front and back views, × 1.625.
7. Anther cap, × 6.5.
8. Pollinia, × 6.5.

PLATE 7

Adenostylis merrillii sp. nov.; habit, reduced.

PLATE 8

Haemaria discolor Lindl.; habit, reduced.

PLATE 9

FIG. 1. *Dendrobium chameleon* Ames var. *ovatilabium* var. nov.; habit, very much reduced.
2. *Dendrobium miyasakii* sp. nov.; habit, very much reduced.

PLATE 10

Eria longissima sp. nov.; habit, very much reduced.

PLATE 11

Eria longissima sp. nov.; flowering stem, natural size.

PLATE 12

Bulbophyllum biflorum Teijsm. and Binn.; habit, reduced.

PLATE 13

Bulbophyllum emiliorum sp. nov.; habit, reduced.

PLATE 14

Bulbophyllum antenniferum (Lindl.) Reichb. f.; habit, reduced.

PLATE 15

FIG. 1. *Bulbophyllum ebracteolatum* Kränzl.; habit, much reduced.
2. *Bulbophyllum ebracteolatum* Kränzl.; closer view showing scape and some pseudobulbs. Slightly reduced.

PLATE 16

Bulbophyllum ornatissimum (Reichb. f.) J. J. Sm.; habit, reduced. (A photograph of the herbarium specimen.)

PLATE 1.

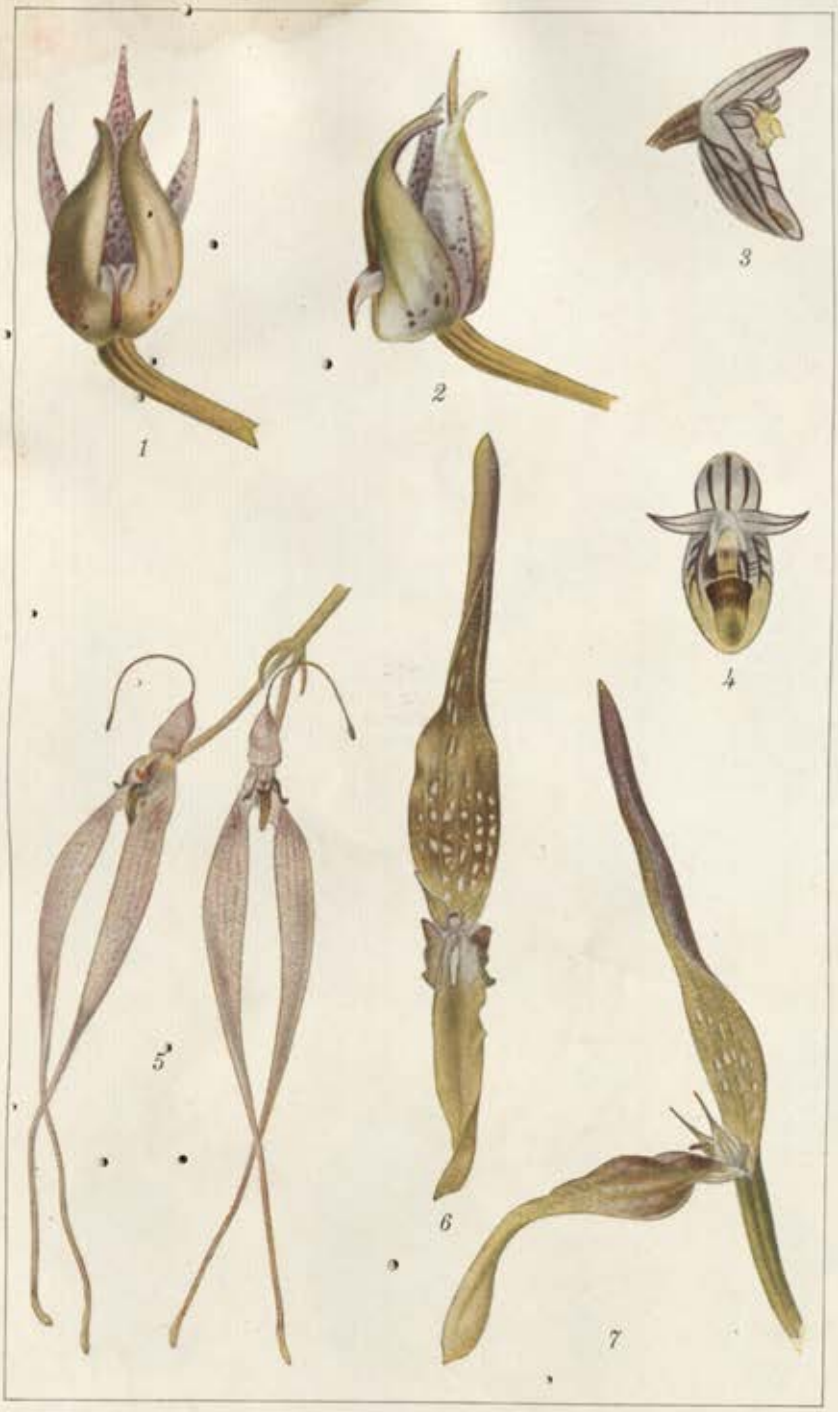


PLATE 2.

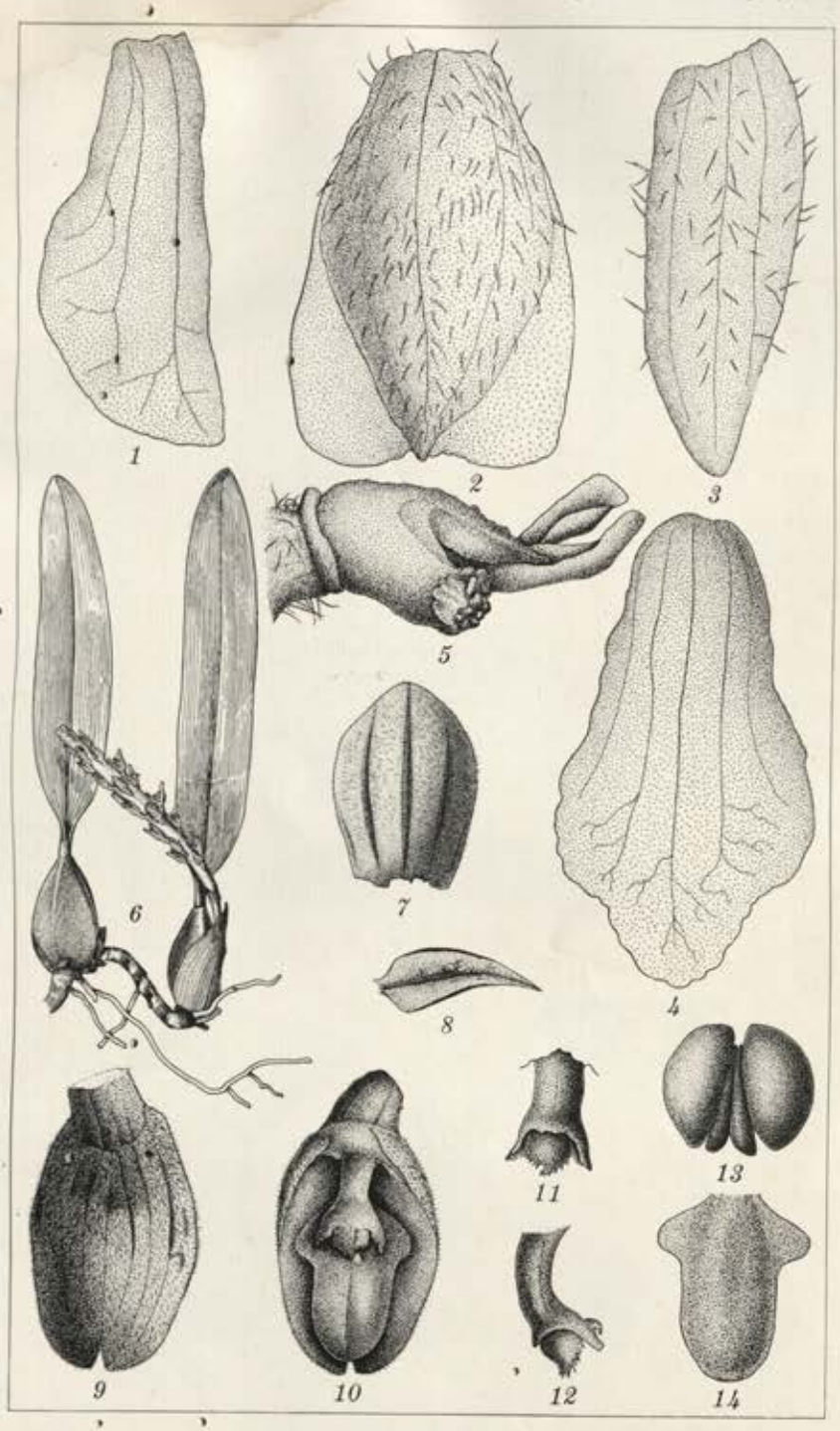
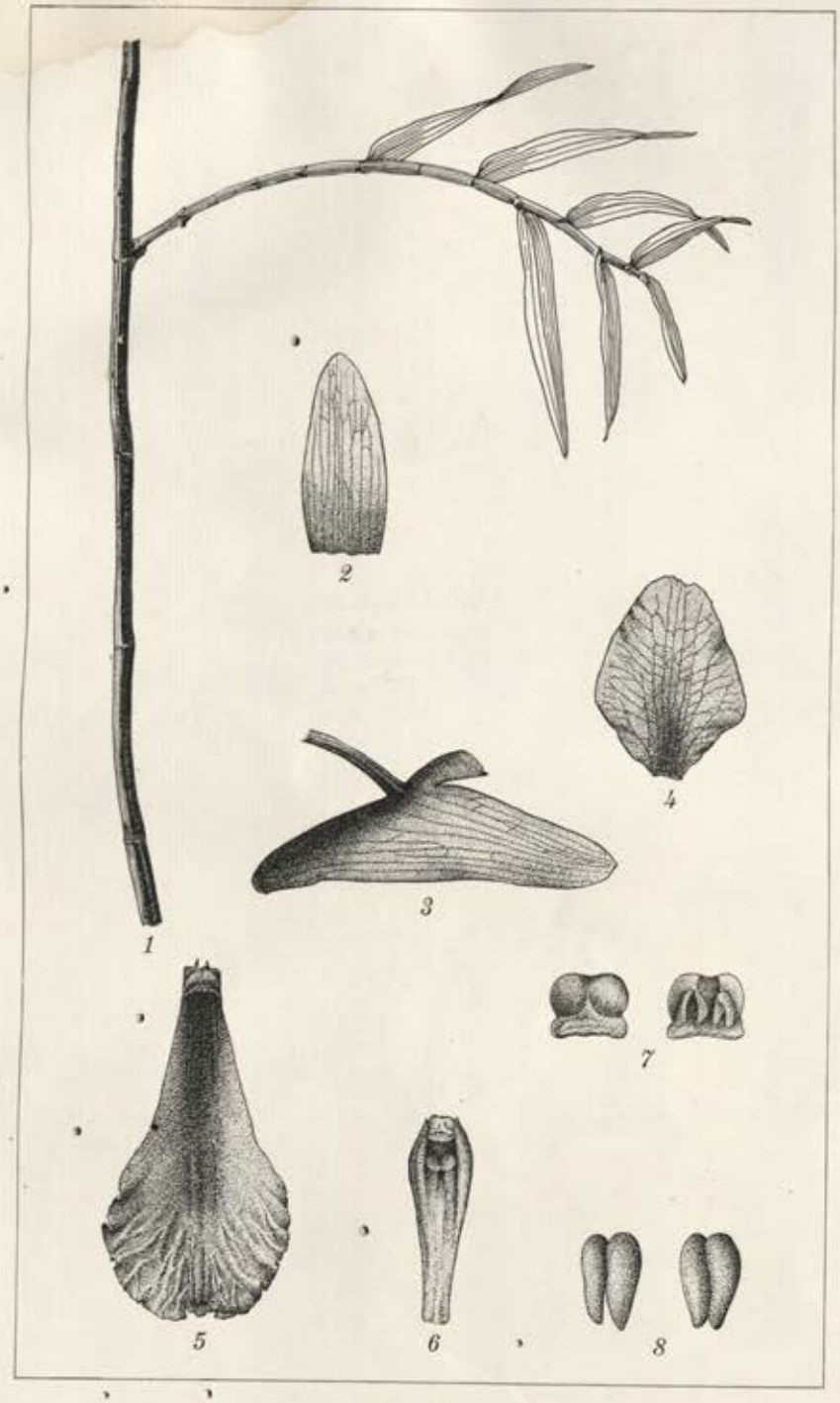


PLATE 3



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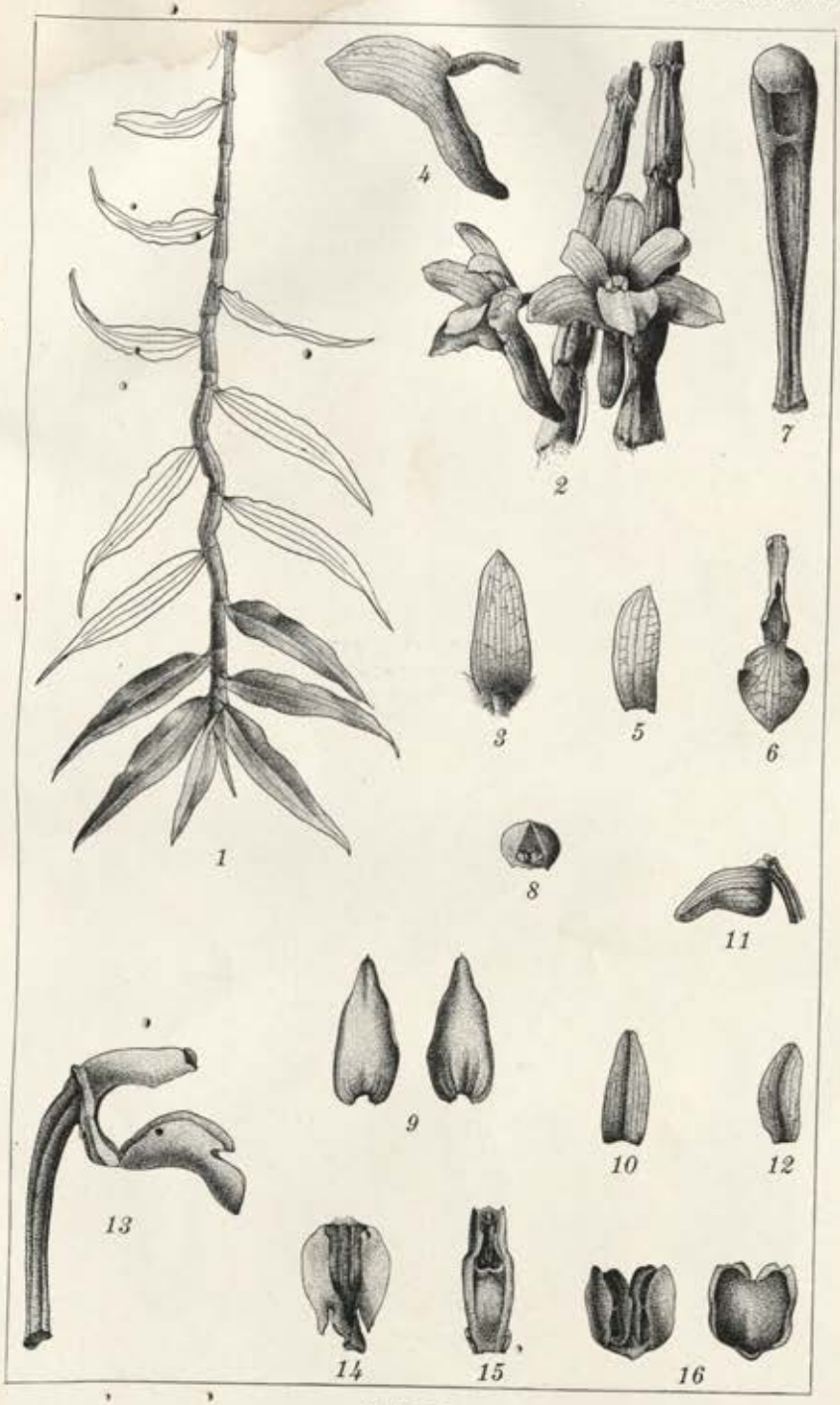

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 8.

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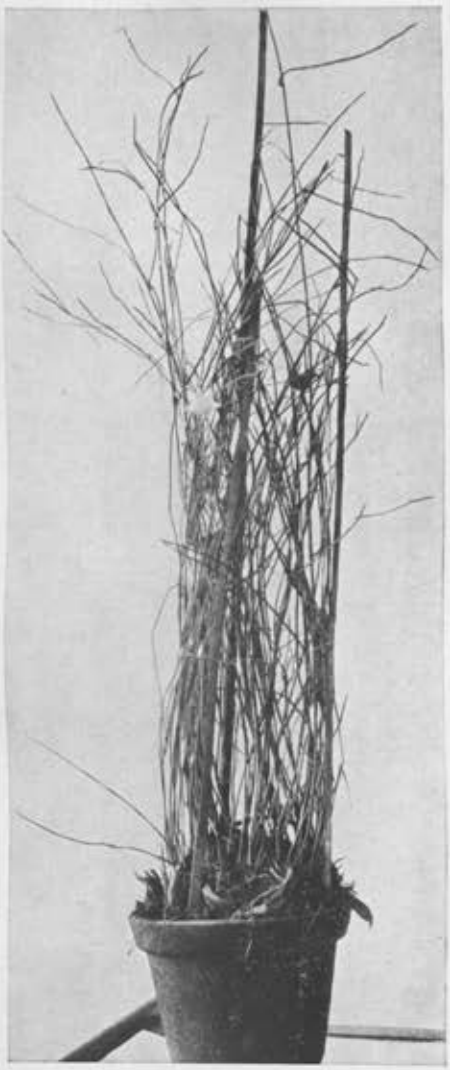

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PLATE 9.

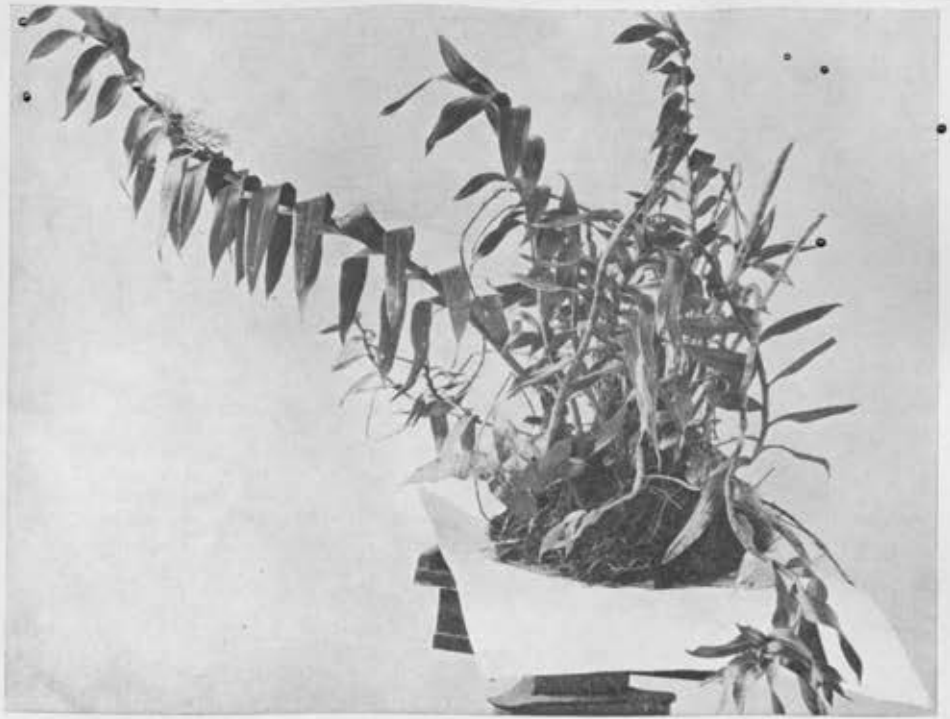

PLATE 10.

PLATE 11.

PLATE 12.

PLATE 13.

PLATE 14.

1

2

PLATE 15.

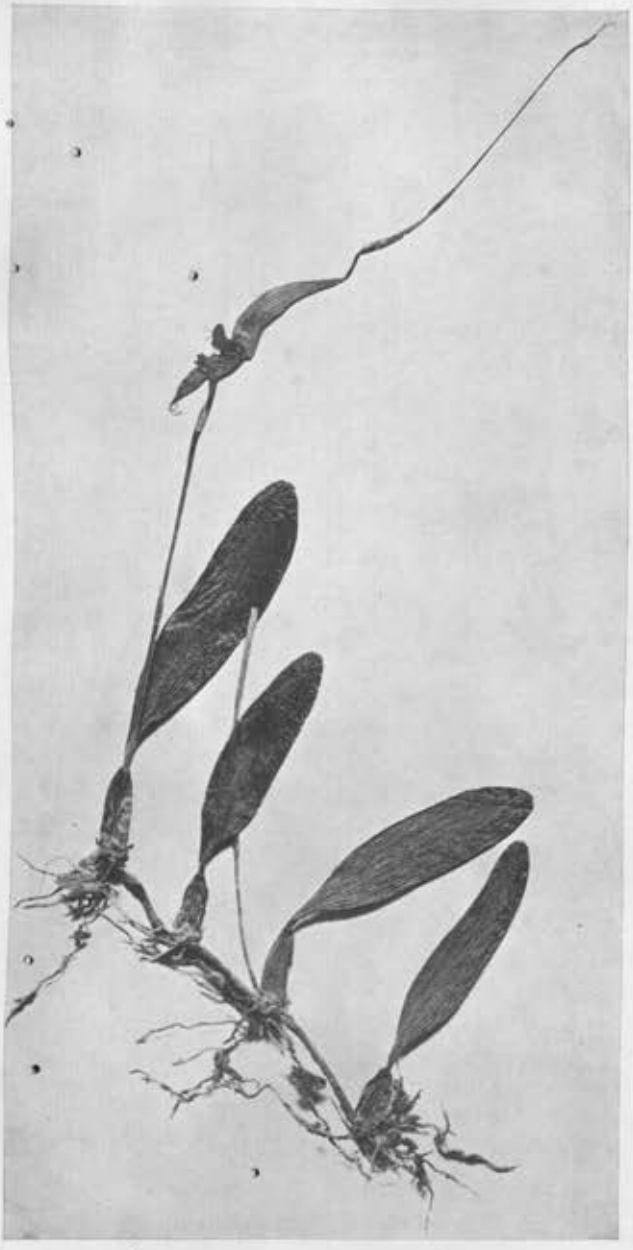

PLATE 16.

ANOMALOUS STEM STRUCTURE IN ARCHANGELISIA FLAVA AND ANAMIRTA COCCULUS FROM THE PHILIPPINES

By José K. Santos

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EIGHT PLATES AND FOUR TEXT FIGURES

In a previously published work of the writer,(5) the general features of the Menispermaceæ, as reviewed by Solereder, were indicated, but no mention was made by the writer concerning the anomalous structure of the stem observed in some of its representatives. This anomaly occurring in the stems of certain members of this family consists of the appearance of a series of concentric rings or zones of vascular bundles. According to Solereder(7) these successive zones of vascular bundles are secondary and extrafascicular in origin, and De Bary(2) describes them as consisting of wood, bast, and limited cambium which, according to him, may be called rings of growth, and that these rings of growth, following the normal one, arise in the primary outer cortex. This peculiar stem structure is developed by an unusual method of secondary thickening formation and, according to Solereder,(7) has only been observed in the following Menispermaceæ: *Cocculus laurifolius* de Candolle, *C. leaeba* de Candolle, *Chondrodendron platyphyllum* Miers, *C. tomentosum* Ruiz and Pavon, *Pericampylus incanus* Miers, *Anomospermum schomburgkii* Miers, *A. grandifolium* Eichler, *Pachygone domingensis* Eichler, *Abuta amara* Aublet, *A. concolor* Poeppig and Endlicher, *A. imene* Eichler, *A. rufescens* Aublet, and *A. selloana* Eichler. From this list, it is quite clear that no case so far has been worked out extensively among the species under the genera *Archangelisia* and *Anamirta*. Since the stems of *Archangelisia flava* (Linnæus) Merrill and *Anamirta cocculus* (Linnæus) Wight and Arnott from the Philippines exhibit a series of concentric rings of wood more or less similar to those of the species enumerated above, this work was undertaken with

the object of revealing further information in connection with the anomalous thickening observed among the stems of some Menispermaceæ.

Archangelisia flava is commonly known as *albustra, abutra,* or *suma.* These names are also applied to *Anamirta cocculus,* although this species is better known as *ligtang.* Both species are large woody vines with stems sometimes reaching 10 centimeters in diameter. They are very similar in their general external features, and in cross sections are both characterized by the presence of a series of concentric rings of wood. The stem of *Archangelisia flava,* however, is commonly distinguished from that of the *Anamirta cocculus* by the yellow color of the wood, whereas that of the latter is white. This yellow color of the stem of *Archangelisia flava* is probably due to the presence of berberine, an alkaloid. According to Wells(8) this species is believed to have a larger percentage of alkaloid than any other plant found in the Philippines. Guerrero(4) states that a decoction of its stem and roots is used by the Filipinos as a febrifuge tonic, emmenagogue or abortive, according to the quantity administered. The stem bark of *Anamirta cocculus* on the other hand, Brown(1) indicates, is made into rope used for tying animals and for hauling. The fruit is employed as fish poison and is also poisonous to other animals.

These two plants are scattered in thickets and forests at low and medium altitudes throughout the Philippines. They are also found in India and Borneo through Malaya to New Guinea.

MATERIAL AND METHODS

The stems of *Archangelisia flava* and *Anamirta cocculus* that furnished the sections for this brief investigation were collected by Mr. Maximo Ramos, of the Bureau of Science, Manila, from the forest of Antipolo, Rizal Province, Luzon, during December, 1928. A young stem from a seedling of *Archangelisia flava* about half a meter high collected by the writer from the foot of Mount Maquiling, Los Baños, Laguna Province, Luzon, in February, 1926, was used in addition to the above material for comparative study.

Several transverse, radial, and tangential sections from 20 to 30 microns thick were prepared, by means of a sliding microtome, from young and mature stems of the two species. These sections were treated with 95 per cent alcohol, stained with safranin, contrasted with Delafield's hæmatoxylin, dehydrated, clarified with xylol, and mounted in balsam. Sections prepared

from the stem of a seedling were not stained but simply mounted in glycerin and used for comparison.

For the comparative examination of the individual shape and characteristics of the cells, Schulze's maceration process, as described by Greenish(3) was employed.

ARCHANGELISIA FLAVA (LINNÆUS) MERRILL

Description of the stem.—The young fresh stems of *Archangelisia flava* are from bright green to dark green, smooth, wiry, and occasionally with small axially elongated lenticels. They bear large broadly ovate leaves about 16 centimeters long, with rounded or slightly obtuse base and accuminate apex. Plate 1, figs. 1 and 2, represents the photographs of the fresh and dried leaves, respectively, with small portions of the young stems. When a fresh young stem is cut it exhibits a ring of yellow vascular bundles, and the cut portion exudes a small quantity of yellowish juice, which has a bitterish taste.

The adult stems from 2 to 4 centimeters in diameter have light brown, very thin bark marked longitudinally with shallow furrows and wrinkles. Here and there yellowish white or greenish patches are observed and sometimes small areas of lichens are found on certain portions of the stem. Prominent knots 25 to 40 centimeters apart, which sometimes throw out a branch, also occur. When it is cut transversally, the stem exudes a scanty yellowish sap with a bitterish taste like that of the young stems, and it displays a series of slightly eccentric zones of yellow woody tissue traversed by radiating medullary rays as illustrated on diagrammatic text figure 1 and in the photographs on Plate 1, fig. 1, *a–d*.

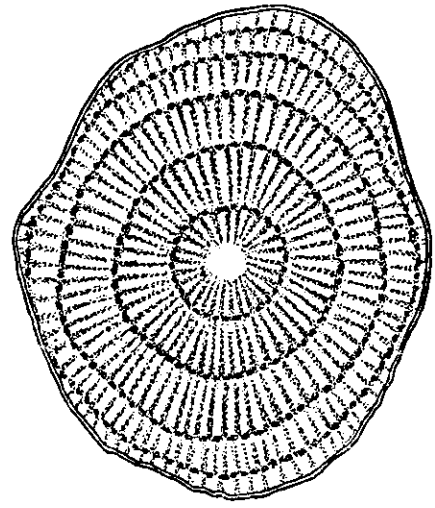

FIG. 1. A diagrammatic view of smoothly cut portion of an adult stem of *Archangelisia flava*, showing the eccentric successive rings of growth. ×1.5.

Structure of the stem.—A thin transverse section of a young stem is circular in outline and is invested by a single layer of

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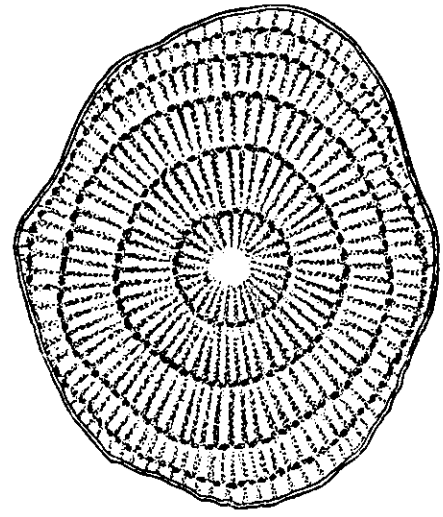

FIG. 1. A diagrammatic view of smoothly cut portion of an adult stem of *Archangelisia flava*, showing the eccentric successive rings of growth. ×1.5.

Structure of the stem.—A thin transverse section of a young stem is circular in outline and is invested by a single layer of

colorless rectangular epidermal cells with moderately thickened and cutinized outer cell walls. The cortex is very thin and is composed of two or three layers of thin-walled collenchyma cells and from four to eight layers of small, somewhat tangentially elongated parenchyma cells, both containing a small amount of chloroplastids. The innermost part of the cortex is limited by an inconspicuous starch-sheath. The pericyclic region consists of an undulated continuous sclerenchymatous tissue, which is made up of the arcs of primary hard bast and parenchyma cells, the latter being in the inner part. In the older sections these arcs of primary hard bast are crescent-shaped, but are united by intermediate groups of stone cells into a composite and continuous undulated ring of sclerenchyma, as illustrated in a diagrammatic representation on Plate 2, fig. 3. The primary vascular bundles vary from ten to sixteen, arranged in the form of a ring and separated from one another by broad, primary medullary rays, which are from six to fifteen rows wide and are composed of radially elongated cells. These medullary ray cells have slightly thickened cell walls and are usually loaded with minute, rounded starch grains, while those of the lateral rows are usually filled with prismatic calcium oxalate crystals. The soft bast is not in immediate contact with the inner part of the hard bast; between the two regions there are large and unlignified parenchyma cells, in which no sieve tubes are found. These large parenchyma cells usually contain either a few, slender, prismatic, calcium oxalate crystals or starch grains or a mixture of the two. The sieve tubes are small polygonal cells with very thin walls, and the companion cells are not conspicuous. The primary xylem is separated from the soft bast by a fascicular cambium. It consists chiefly of vessels with large lumina and of wood-prosenchyma with bordered pits. The vessels, which measure from 0.06 to 0.25 millimeter in diameter, possess simple perforations and have bordered pits even where they are in contact with parenchyma, and one or two have spiral or annular thickenings. The pith is wide and circular in outline. It is more or less differentiated by division into two distinct inner and outer regions. The inner region consists of large, polygonal, thin-walled parenchymatous cells with small intercellular spaces. Some of these cells are usually filled with either prismatic raphides, or micro-crystals of calcium oxalate, and starch grains. Occasionally, here and there, a few stone cells are found in the middle region. The outer region, which is limited in the peripheral part by a ring of primary

xylem, is built up of several layers of small, polygonal cells with thick walls resembling the transverse section of the long sclerenchymatous cells, but differing from the latter in that the former exhibit small intercellular spaces, and have thinner walls and are not greatly elongated in the longitudinal section, while some of them usually contain calcium oxalate crystals.

Secretory sacs.—Structures that are more or less similar to the bitter-principle sacs observed by the writer(5) in *Tinospora rumphii* Boerlage and *T. reticulata* Miers are found in the cortical region and in the peripheral part of the pith of *Archangelisia flava.* These structures may be called secretory sacs. In cross section they appear very similar to the ordinary parenchyma cells. They are either circular or polygonal in outline with very thin walls and usually contain a yellowish granular substance. In the cortex they are found scattered and intermingled with the cortical parenchyma cells and frequently are found in the outer part of the bast-fiber region or sometimes mixed with the bast fibers as shown on Plate 3, fig. 11. In the peripheral part of the pith the secretory sacs are intermingled with the pith cells with thick walls. They are distinguished, however, from the latter by their thin walls and yellowish granular content. Plate 3, fig. 14, represents a small portion of the transverse section of the pith showing the two kinds of parenchyma cells with thick and thin walls, respectively, and a secretion cell. In the longitudinal section the secretory sacs are axially elongated. They vary in length from 0.45 to 1.2 millimeters and are about 0.03 millimeter in diameter. They are either straight or crooked. Plate 4, figs. 15 and 16, exhibits the characters of the secretory sacs in the longitudinal section.

A critical study of the secretory sacs of *Archangelisia flava* revealed that they originate and develop as a consequence of the gradual and complete disappearance of the cross walls of a row of parenchyma cells in the cortical and pith regions of the stem. They usually occur as independent tubes of various lengths and they possess all the characteristics of the articulated latex tubes, but differ from the latter in that the secretion sacs are not greatly elongated and they neither anastomose nor branch.

The structure of a thin transverse section of an adult stem, however, is much more complicated, on account of its anomalous thickening. The periderm is thin and fissured in various places. It originates from the subepidermal regions. Its formation seems to take place soon after the greatest activity of the fas-

cicular cambium of the primary vascular bundle has started. It begins to develop in circumscribed areas of the stem, and then gradually spreads peripherally, as it penetrates deep into the cortex. The first indication of the formation of the periderm is the slight elongation of the subepidermal cells in a radial direction in a certain part of the stem and this is followed by a tangential division. The inner layer of the resulting daughter cells in this division becomes the meristemic or phellogen region, and the daughter cells towards the epidermis may divide once or twice before they are converted into cork cells. After the phellogenetic centripetal activity in the formation of the periderm has continued for a time, the first phellogen layer thus formed ceases to divide, and becomes replaced by the subsequent layer of cells from the cortical region. This new phellogen layer is in turn replaced by another layer of cells, also from the cortex, after producing in centripetal successions additional increase in the periderm, and so continues successively. While this process is going on, the phellogen layer gradually becomes extended around the stem until its two sides meet forming a complete ring. The periderm cells are tangentially elongated with delicate cell walls, and they alternate with groups of short sclerenchymatous elements or stone cells which contain a brown substance. These stone cells generally form massive irregularly concentric zones, as shown diagrammatically in text fig. 2. A detailed structure of a segment of the periderm is indicated in Plate 2, fig. 4. The outer cortical region is chiefly of parenchymatous character with a few stone cells scattered over it. It is from fifteen to twenty layers of cells deep and is not sharply limited in the inner part by a starch sheath nor by a pericyclic region, as regularly observed in the structure of a transverse section of an ordinary dicotyledonous stem. On the other hand it is bounded on the inner part by one or two layers of stone cells, which form a continuous ring in the outer part of the soft basts of the secondary vascular bundles.

The wood cylinder, or the stele is pluriseriate in character; and it, especially the method of its development, constitutes an essential part of this investigation. Its transverse section exhibits several concentric rings of vascular bundles, which either encircle one another completely on all sides of the transverse section, or develop strongly only on one side. The number of these successive rings varies according to the relative size and age of the stem. Text fig. 2 gives a diagrammatic view of a segment of a transverse section of an adult stem, which shows

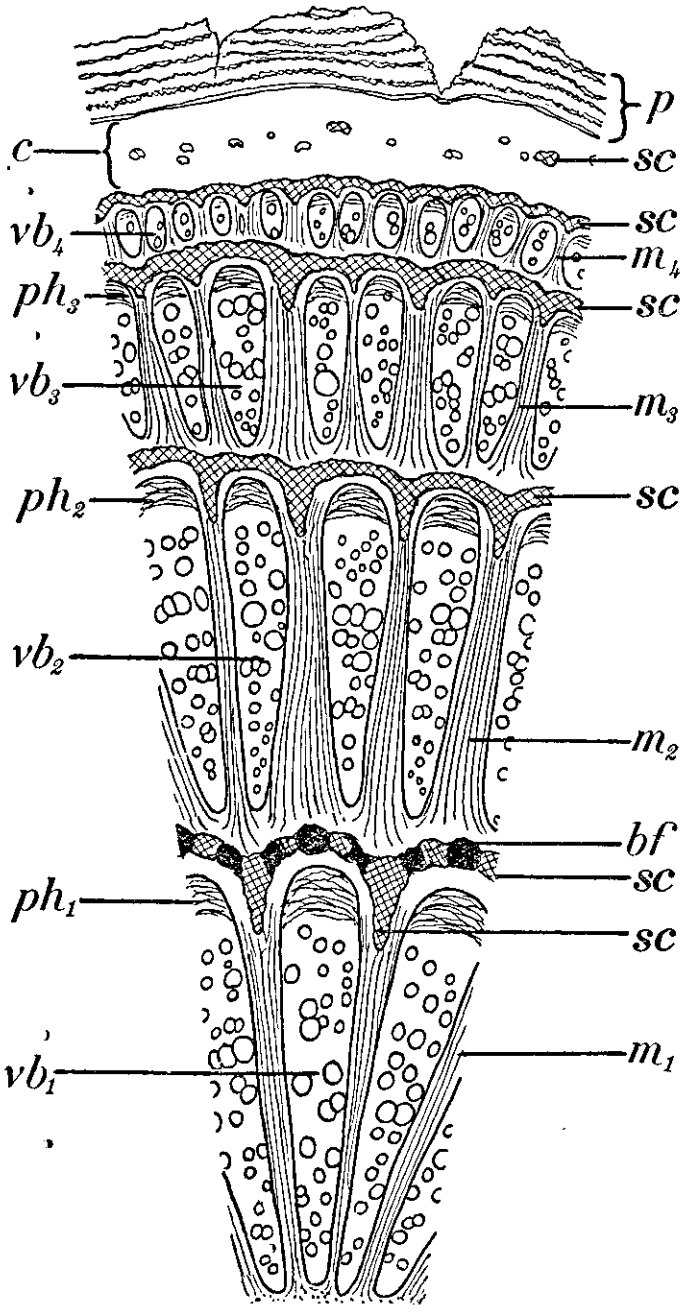

FIG. 2. A diagrammatic camera lucida sketch of a segment of a transverse section of *Archangelisia* adult stem; *p*, periderm; *c*, cortex; *sc*, stone cells; m_1–m_4, medullary rays; vb_1–vb_4, vascular bundles; ph_1–ph_3, phloëm; *bf*, bast fibers.

four successive rings of vascular bundles in various stages of development. These successive rings of growth are separated from one another by groups of stone cells, which are arranged in the form of a continuous and slightly undulated ring. To the naked eye this separation of the individual rings of growth gives the structure the general appearance of a conifer or other dicotyledonous stem that displays characteristic annual rings. A critical examination of the wood of *Archangelisia flava*, however, reveals that its structure is far from being similar to that of a conifer stem or other dicotyledonous stem that exhibits annual rings of growth; for the successive rings of the former consist of groups of vascular bundles, which are arranged in the form of rings and these vascular bundles are separated from one another by broad medullary rays.

The formation of the above-described successive rings of vascular bundles, which constitute the woody part of the stem of *Archangelisia flava*, takes place after a normal secondary thickening of the primary wood and soft bast, in which the activity of the fascicular cambium has already ceased. The growth of the successive rings of vascular bundles is initiated by a group of meristematic cells that develop in the one or two inner layers of parenchyma of the outer primary cortex, which are rich in starch. The first change observed in these parenchyma cells is a radial extension followed by tangential divisions, the latter proceeding usually, but not always, in a centripetal direction. Then a layer of stone cells gradually develops just in the outer part of this meristematic region, which ultimately forms a continuous ring in the peripheral part. Inward from this stone-cell ring the tangential divisions in centrifugal progression of the extra-fascicular meristem continue until the region becomes relatively thick. Plate 2, fig. 5, is a detailed drawing of a segment of the inner cortical region showing the formation of the outer stone-cell ring, and fig. 6 represents an older stage in which the soft bast, *sb*, begins to differentiate from the inner layers. While the tangential divisions coupled with slight radial divisions of the extra-fascicular meristem continue actively, the bast region becomes more pronounced; some of the cells in the inner layers gradually passing over into the thick-walled parenchymatous cells and a secondary cambial layer rises up between the two regions, as illustrated on Plate 2, fig. 7. As the secondary procambial activity is in progress, the cells between the procambial strands become radially elongated and eventually develop into secondary medullary rays,

which are usually formed in the same radial direction as the primary ones. By means of the above process a second ring or arc of vascular bundles is formed, which likewise increases in thickness for some time by the activity of its normal cambium. Plate 2, fig. 8, is a young secondary vascular bundle with two vessels, one of which is derived from the activity of its normal cambium and the other by simple differentiation from a parenchymatous cell. The two sides are limited by broad medullary rays, the cells of which contain prismatic calcium oxalate crystals and minute starch grains. After the cambiogenetic increase in thickening of the second ring has continued for some time, the activity of its cambium ceases. Between the outer part of the stone-cell ring of the second layer of vascular bundles and the new stone ring, developed in the inner layers of parenchyma cells of the outer cortex, as was that of the preceding one, another extra-fascicular cambium appears; from which second set of procambial strands there arises a third ring of vascular bundles of the same structure as those of the second short ring of growth. This process is repeated and continues until a big series of successive concentric rings of vascular bundles is formed. Sometimes the extra fascicular meristem, however, does not divide and differentiate at the same time, so that there are unequal divisions or increases in thickness around the peripheral part of the stem. These result in the eccentric position of the pith or eccentric arrangement of the rings. A more or less similar method of anomalous secondary thickening has been observed by the writer(6) in the stem structure of *Chenopodium ambrosioides* Linnæus.

The individual structure of the vascular bundles of the secondary rings is in all respects very similar to that of the primary, but the bast bundles have no sheath of sclerenchymatous cells or bast fibers. The soft bast, or phloëm region, is almost semicircular in transverse section and is composed of sieve tubes, companion cells, and phloëm parenchyma. The phloëm cells towards the periphery are mostly flattened or shriveled, forming an arc-shaped dark zone in which the individual structure of the cells disappears, but those towards the cambial region are more or less polygonal in outline or sometimes nearly rectangular (text fig. 2).

The xylem region consists chiefly of vessels, wood parenchyma, and wood fibers. The vessels are characterized by their large circular or somewhat elliptic lumina and are visible even to the naked eye. Like the vessels observed in the primary vascular

bundles, these have bordered pits even in places where they are found in contact with the wood parenchyma cells. Plate 3, fig. 9, is a detailed drawing of a middle portion of the transverse section of a vascular bundle, showing the large vessels surrounded by a mass of wood parenchyma and wood fibers, two of them with young growth of tyloses. The wood parenchyma and wood fibers are polygonal in outline, with thick, slightly lignified, pitted walls. Some of the wood parenchyma, especially of the lateral part of the vascular bundle, contains calcium oxalate crystals. When a piece of the wood is macerated with nitric acid and potassium chlorate, the vessels appear as short cylinders, beaker- or barrel-like in outline, with tangentially elongated simple pits. They measure from 0.05 to 0.3 millimeter in diameter and from 0.2 to 0.4 millimeter in length. The wood fibers or libriform fibers are greatly elongated, with somewhat crooked cells and thick, lignified and pitted walls, both ends of which are pointed. They measure about 0.02 millimeter in diameter and from 0.5 to 1.2 millimeters in length. The bast fibers are very slender, with pointed ends and greatly reduced cavities. They measure about 0.02 millimeter in diameter and from 0.7 to 1.4 millimeters in length. The wood parenchyma, like the wood fibers, have thick and slightly lignified cell walls with simple perforations, but they are shorter and their two ends may be either pointed or blunt. They measure from 0.3 to 0.8 millimeter in length. (Plate 4, fig. 17, *a–g*.) The stone cells are conspicuous and show a diversity of form and size, measuring from 0.03 to 0.1 millimeter in width and from 0.04 to 0.25 millimeter in length.

In the radial sections, through either the vascular bundles or medullary rays, the different zones of wood or short rings of growth are also distinct. This is due to the columns of stone cells that separate one zone from another. These columns of stone cells stand out even to the naked eye. These stone cells are either polygonal in outline or radially elongated with very thick cell walls, which have branched perforations and small lumina.

The secondary medullary rays are similar in structure to the primary medullary rays, although they are usually much wider and are not lignified. The primary ray cells are mostly lignified. In transverse sections they appear uniform in structure, consisting of ten to twenty thin- or thick-walled, pitted, and radially elongated cells, which usually contain calcium oxalate crystals,

especially those of the lateral part, and minute rounded starch grains. The parenchyma of the medullary rays, between the masses of bast and the adjoining outermost part of each medullary ray of the xylem, become sclerosed in character. In the radial sections the ray cells appear rectangular in outline, arranged in rows perpendicular to or at right angles to the vascular tissue. The number of the radial rows varies according to the relative size of the medullary ray. In the tangential section on the other hand, the medullary rays appear as boat-shaped areas. The medullary ray cells are polygonal in outline; and those of the lateral part, like those in the transverse section, usually contain large calcium oxalate crystals, which are either prismatic, cubical, rhomboidal, or irregular in shape. The cells in the middle part are filled with minute rounded starch grains or sometimes mixed with a few slender prismatic or rod-shaped calcium oxalate crystals. Plate 3, fig. 12, is a detailed representation of a segment from the lateral part of a transverse section of a medullary ray, showing the different forms of calcium oxalate crystals and starch grains. Plate 3, fig. 13, gives an actual view of a portion of a tangential section of a medullary ray, and displays a large stone cell in the middle part and the characteristic shape of the ray cells with their different forms of calcium-oxalate-crystal content. At the lateral part, the medullary ray is limited by wood parenchymatous cells with bordered pits.

The central pith of an old stem is comparatively the same as that of a young one. It is also circular in outline, measures about 4 millimeters in diameter, and is differentiated into inner and outer zones (Plate 3, fig. 14). Like the central pith of the younger stem, the inner zones are occupied by large polygonal parenchymatous cells with small intercellular spaces, but with thicker, pitted, and slightly lignified cell walls. Some of them contain calcium oxalate crystals in raphides or microcrystals. The only difference is that very often in the pith of the old stem there are some stone cells present. The outer zones, like the outer zones of the younger stem, consist of fourteen to eighteen layers of small polygonal cells with thick, lignified, and distinctly striated cell walls, resembling the transverse sections of the sclerenchymatous cells, but they differ from the latter because they are mostly filled with microcrystals, raphides, or clinorhombic forms of calcium oxalate and because they are not greatly elongated axially.

ANAMIRTA COCCULUS (LINNÆUS) WIGHT AND ARNOTT

The young, fresh stems of *Anamirta cocculus* are almost of the same general appearance as those of *Archangelisia flava*, for they are also from bright green to dark green, smooth, wiry, and with axially elongated lenticels in the older part. The former species differs from the latter, however, in that the leaves are from 12 to 25 centimeters in length, smooth, shiny, and with cordate base and acuminate apex. Plate 5, figs. 18 and 19, gives a view of the external characteristics of the stem and leaves. When a fresh young stem is cut transversely it displays a ring of vascular bundles, which are visible to the naked eye. The cut portion has a whitish color and exudes a scanty whitish or colorless sap with a slightly bitterish taste.

The external characteristics of the adult stems of *Anamirta cocculus* from 2 to 3 centimeters in diameter are also similar to those of *Archangelisia flava*, but the former differ from the latter by their straw to grayish brown color and numerous shallow longitudinal fissures and wrinkles, which sometimes take a spiral direction. *Anamirta cocculus* is not usually covered by greenish patches or by lichens, but prominent knots, which sometimes throw out branches, occur at intervals of about 35 centimeters. The fresh older stems of both *Anamirta cocculus* and *Archangelisia flava*, when cut transversally, display series of concentric rings of wood with conspicuous radiating medullary rays, but the cut portion of the former has whitish wood and exudes a scanty whitish sap, whereas the wood of the latter is yellow and exudes a yellow sap. Plate 5, fig. 18, shows a photograph of four pieces of the older stems of *Anamirta cocculus* of different diameters. When dried the stems shrink slightly, but the fissures and wrinkles become more prominent and the wood turns grayish brown. The wood of *Archangelisia flava*, on the other hand, becomes yellowish brown when dried.

Structure of the stem.—The anatomical structure of a thin transverse section of a young stem of *Anamirta cocculus* is similar to that of the young stem of *Archangelisia flava*. The cortex is also very thin; it is invested in the outer part by a single layer of epidermal cells, and in the inner part by an inconspicuous starch sheath. The pericycle, like that of *Archangelisia*, is composed of a many-layered, undulated, continuous ring of sclerenchymatous cells, formed by arcs of the primary hard and soft bast. The vascular bundles are from twelve to

eighteen, collateral, and arranged in the form of a ring with broad medullary rays between them. These primary vascular bundles are very similar in general character to those of *Archangelisia,* but they are relatively longer in a radial direction, are wider, and their microscopical structure is coarser than that of the primary vascular bundles of the latter. Plate 6, fig. 20, gives a diagrammatic view of a young stem of *Anamirta cocculus,* in which the normal secondary thickening in the soft bast and wood and the thickening in the outer cortex have already started. The protoxylem and metaxylem vessels are comparatively larger than the corresponding vessels observed in *Archangelisia flava.* However, they possess the same characteristics in that they have tangentially elongated bordered pits; the medullary rays are from eight to sixteen rows of cells wide; and the medullary ray cells, like those of *Archangelisia flava,* have thick walls, loaded with rhomboidal or prismatic calcium oxalate crystals and minute starch grains.

The central pith of the young stem of *Anamirta cocculus* is also very similar to that of *Archangelisia flava.* The outline is circular, and the pith is differentiated into inner and outer zones. The central pith is comparatively wider than that of *Archangelisia flava,* and the cells composing the inner and outer zones have relatively thinner walls and contain only starch grains, as represented on Plate 7, fig. 32.

Secretory sacs.—According to Solereder,(7) Bailon was the first to observe in *Anamirta* certain structures which he called secretory sacs and that they were described by Blottiere as "Cannaux laticiferes." The works of Bailon and Blottiere are not available. The secretory sacs found in *Anamirta cocculus* are very similar in structure to those observed in *Archangelisia flava.* They originate and develop in the same manner; that is, by the dissolution of the cross walls of certain rows of parenchyma cells. Like the secretory sacs of *Archangelisia* they appear as independent tubes of various lengths, scattered in the cortical region and in the outer zone of the central pith of the stem. The secretory sacs of *Anamirta* are much wider and longer than those of *Archangelisia,* and they contain a granular grayish white substance. They measure about 0.06 millimeter in diameter and from 0.75 to 3 millimeters in length. On Plate 7, fig. 29, is a segment of a radial section through the cortex, showing a portion of a longitudinal view of a secretory sac.

The structure of a thin transverse section of an adult stem of *Anamirta* is similar to that of *Archangelisia*. It is also characterized by a series of concentric rings of vascular bundles of extra-fascicular origin, which are separated from one another by broad medullary rays as indicated in text fig. 3. Text fig. 4 is a diagrammatic view of a segment from a thin transverse section of a stem about 4 centimeters in diameter. The periderm is also very thin and developed from the subepidermal region in the same manner as that of *Archangelisia*. It is fissured in various places and displays the characteristic stone cells forming massive irregularly concentric zones which alternate with the thin-walled and slightly suberized cork cells. Plate 6, fig. 21, gives a detailed view of a segment of a transverse section of the periderm, which is very similar to the corresponding section in *Archangelisia* indicated on Plate 2, fig. 4, but it is coarser in structure than the latter.

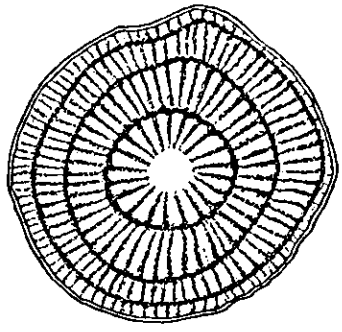

FIG. 3. A diagrammatic representation of the cut surface of the stem of *Anamirta cocculus*, showing the successive rings of growth. × 1.5.

The cortex of an adult stem of *Anamirta* is thinner than that of *Archangelisia*. It consists of ten to fifteen layers of thin-walled parenchymatous cells with a polygonal, rounded, or tangentially elongated outline. Comparatively, there are fewer stone cells in the cortical parenchyma region of *Anamirta* than in that of *Archangelisia*. The secretion cells are not conspicuous in the cortex of an adult stem and presumably they are fewer than in that of younger stems.

The wood cylinder of an adult stem of *Anamirta*, like the wood cylinder of *Archangelisia* of about the same age, is pluriseriate. The first normal ring of thickening surrounds a very wide pith. Its irregular undulating outer margin, similar to that of *Archangelisia*, is marked off from the outer ring of vascular bundles by a composite and continuous sclerenchymatous ring, which is composed of the arcs of the primary hard bast and stone cells. The wood shows practically the same structure as the corresponding region in *Archangelisia* and is arranged in very regular radial rows also, but the vessels are comparatively larger, measuring from 0.06 to 0.35 millimeter in diameter. The broad,

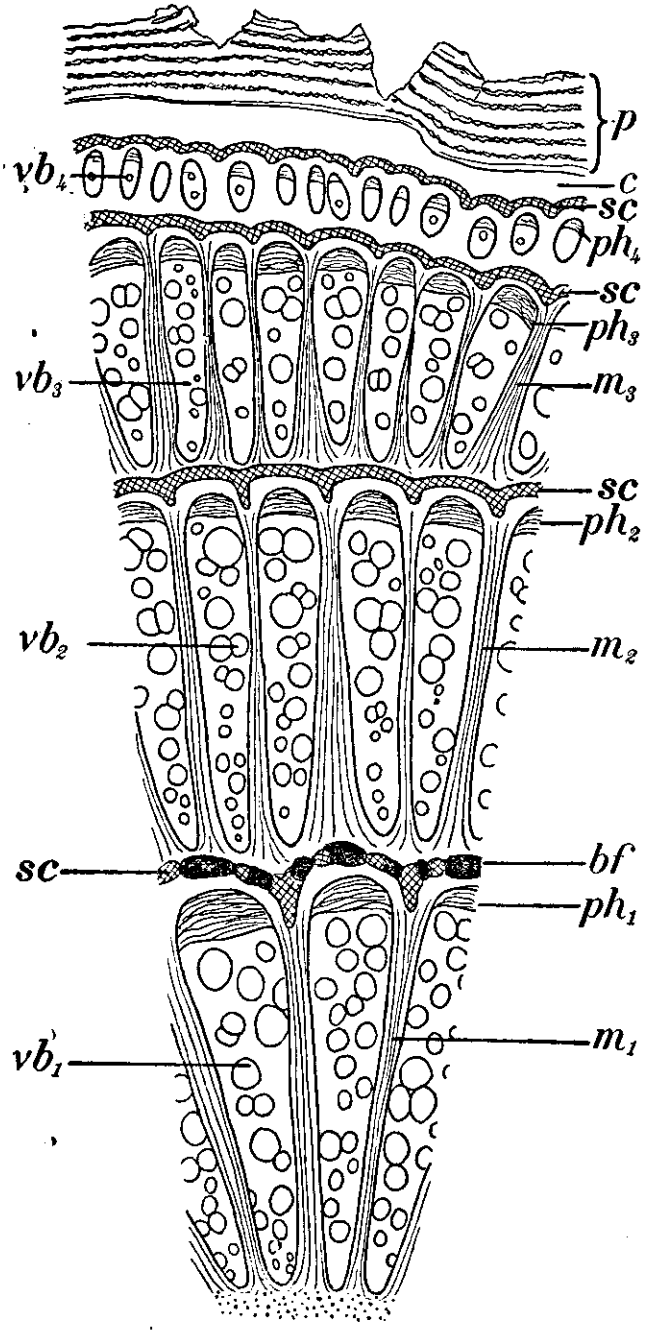

FIG. 4. A diagrammatic camera lucida sketch of a segment of a transverse section of *Anamirta* adult stem; *p*, periderm; *c*, cortex; *sc*, stone cells; m_1–m_3, medullary rays; vb_1–vb_4, vascular bundles; ph_1–ph_4, phloëm; *bf*, bast fibers.

pluriseriate, primary medullary rays consist of twelve to twenty-four rows of rather thick-walled, pitted, and slightly lignified cells, the lateral rows of which contain calcium oxalate crystals and the middle ones, starch grains. The second ring of thickening which surrounds the first one, is limited in the outer part and separated from the third outer ring by one or two layers of polygonal or radially elongated stone cells. This zone of vascular bundles is derived directly from the inner part of the cortex or from just inside the outer limiting region of the sclerenchymatous ring. The first signs observed in the formation of the secondary ring of thickening in *Anamirta* are the irregular divisions of the three or four inner layers of parenchyma cells of the cortex, which increase the thickness of the cortex. The resulting daughter cells in these divisions are small, with polygonal outline, as indicated on Plate 6, figs. 22, 23, and 24. Following the slight increase in the cortex there appear small groups of cells with thicker walls. These are sometimes arranged in radial rows or in patches; in the places where the corresponding future secondary vascular bundles are to be located as the differentiation and the multiplication of the cells is in progress, secondary procambial strands arise, followed by the development on the outer side of a ring or arc of stone cells. From the procambial strands a second ring, or arc, of vascular bundles is formed and likewise grows in thickness for some time by means of its normal cambium. To this short ring of growth a third and then numerous successive thickening rings are added, always in the same manner. Plate 6, fig. 25, represents a detailed reproduction of a young secondary vascular bundle, showing the structure of the semicircular soft bast region, the early stage of fascicular cambium, and a massive prosenchymatous tissue with a small vessel at one side. In the peripheral and in the inner parts it is limited by layers of stone cells, which are either polygonal or radially elongated, with small cavities and very thick, highly lignified, pitted walls. It is bounded at the two lateral parts by broad medullary rays, which are composed of radially elongated thin-walled cells, some of which contain a few calcium oxalate crystals and some starch grains.

As in *Archangelisia*, the fully developed secondary vascular bundles are similar in structure to the primary vascular bundles. The only difference between these two kinds of bundles is that the soft bast of the former is deprived of sclerenchymatous arcs

or hard bast. The phloëm region consists of the same elements; namely, sieve tubes, companion cells, and phloëm parenchyma. The xylem is composed of very large vessels, wood parenchyma, and wood fibers. The vessels like those in the primary xylem possess simple, tangentially elongated perforations. Plate 7, fig. 26, is a segment of a transverse section of a secondary vascular bundle, showing a very large and a small vessel surrounded by a mass of wood parenchyma and wood fibers. The wood fibers of *Anamirta* are distinctly longer and have more-pointed ends than those of *Archangelisia.*

When a portion of the stem of *Anamirta* is treated with nitric acid and potassium chlorate, the most conspicuous elements observed under the microscope are somewhat similar to those of *Archangelisia flava* as shown on Plate 8, fig. 32, *a–f*. The stone cells exhibit a great diversity of form and size. They measure from 0.04 to 0.1 millimeter in diameter and from 0.05 to 0.3 millimeter in length. The wood fibers are slender, measuring about 0.035 millimeter in width and from 0.6 to 1.35 millimeters in length. They appear either straight or crooked with pitted walls. The bast fibers are much longer than those found in *Archangelisia flava,* measure from 1.5 to 2 millimeters in length and about 0.03 millimeter in width, and have a greatly reduced cavity. The wood-parenchyma are characterized by the profuse pittings of their walls. They are from 0.2 to 0.8 millimeter in length and about 0.04 millimeter in width, and are either straight or crooked with slightly tapering ends. The vessels are from 0.05 to 0.5 millimeter in diameter and from 0.15 to 0.55 millimeter in length. They are either beaker-like, barrel-like, or cylindrical with simple tangentially elongated pits, and the medullary ray cells are short with thick pitted walls.

SUMMARY AND CONCLUSIONS

1. The younger stems of *Archangelisia flava* and *Anamirta cocculus* externally are very similar, but internally differ distinctly. The wood of the former is yellow and has a yellowish juice; the wood of the latter is whitish and secretes colorless juice.

2. In the transverse sections both stems exhibit a ring of vascular bundles that are separated one from another by broad medullary rays. The pericycle consists of an undulated continuous sclerenchymatous tissue, which is made up of the arcs of primary hard bast.

3. Secretory sacs, which originate and develop through the disappearance of the cross walls of a row of parenchyma cells, are observed in the cortical region at the outer zones of the central piths of both stems.

4. The secretory sacs of *Archangelisia flava* are smaller and usually more crooked than those of *Anamirta cocculus*.

5. The general characteristics of a thin transverse section of an adult stem of *Archangelisia flava* are very similar to those of the stem of *Anamirta cocculus* of corresponding age. They both exhibit successive concentric or eccentric rings of vascular bundles of secondary and extrafascicular origin, a peculiar and unusual method of secondary thickening formation.

6. The stem of *Archangelisia flava*, besides being yellow, differs as a whole from the structure of the stem of *Anamirta cocculus* in that the tissue of the former in general is finer than that of the latter. The bast fibers, wood fibers, wood parenchyma, and vessels of *Anamirta cocculus* not only possess larger diameters, but also are much longer, comparatively, than those of *Archangelisia flava*.

7. Calcium oxalate crystals of various shapes and sizes are observed in the cortical parenchyma, medullary-ray cells, and pith cells. The calcium oxalate crystals of *Archangelisia*, however, are usually prismatic, clinorhombic, or raphides, whereas those of *Anamirta* are either rhomboidal, cubical, clinorhombic, or raphides.

8. The cells of the peripheral zones of the pith of *Archangelisia* are usually loaded with calcium oxalate crystals in raphides or prismatic forms, with a very few starch grains and only a few secretory sacs intermingled with them, whereas the cells of the corresponding zones in *Anamirta* usually contain starch grains only and relatively more secretory sacs are intermingled with them.

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ILLUSTRATIONS

[Most of the microscopic drawings were prepared by Mr. Mariano Abagon and some are by the author. The photographs are by the Bureau of Science photographer.]

PLATE 1. ARCHANGELISIA FLAVA (LINNÆUS) MERRILL

FIG. 1. Four short fresh stem portions, or pieces, of different diameters showing the successive rings of growth and a small part of a young stem with two fresh leaves.

2. A photograph of a portion of a dried specimen bearing fruit.

PLATE 2. ARCHANGELISIA FLAVA (LINNÆUS) MERRILL

FIG. 3. A diagrammatic view of a transverse section of a young stem; *p*, periderm; *c*, cortex; *sc*, stone cells; *pe*, pericycle; *ph*, phloëm; *x*, xylem; *m*, medullary ray. × 10.5.

4. A small segment of the periderm; *sc*, stone cells; *ph*, phellogen; *c*, cortical parenchyma. × 275.

5. A segment from the inner cortical region, showing the formation of the outer secondary stone-cell ring; *sc*, stone cells; *co*, calcium oxalate crystals. × 165.

6. An older stage corresponding to the region shown in fig. 5, in which the outer secondary stone-cell ring is more or less completed; *sb*, soft bast; *sc*, stone cells. × 165.

7. An early stage of a secondary vascular bundle gradually developed by the differentiation of the parenchyma cells; *ph*, phloëm; *pc*, procambial region; *p*, parenchyma cells with thick walls; *sc*, stone cells; *m*, medullary ray. × 165.

8. A young vascular bundle; *ph*, phloëm; *sc*, stone cells; *fc*, fascicular cambium; *v*, vessel; *m*, medullary ray; *co*, calcium oxalate crystals. × 165.

PLATE 3. ARCHANGELISIA FLAVA (LINNÆUS) MERRILL

FIG. 9. A segment from the middle part of a primary xylem; *v*, vessel; *t*, young stage of tyloses; *wp*, wood parenchyma and wood fibers; *co*, calcium oxalate; *m*, medullary ray. × 165.

10. A portion of the bast-fiber region from the outer part of primary phloëm; *sc*, stone cells; *bf*, bast fibers. × 275.

11. A very small segment taken from the region between the cortex and the bast fibers; *s*, secretion cells; *bf*, bast fibers; *cp*, cortical parenchyma. × 700.

12. A group of medullary-ray cells from a transverse section of the stem; *co*, calcium oxalate crystals; *sg*, starch grains. × 700.

13. A portion of the tangential section of a medullary ray; *m*, medullary-ray cells; *sc*, stone cells; *co*, calcium oxalate crystals; *wp*, wood parenchyma. × 165.

FIG. 14. A portion of the central pith showing the differences between the cells of the inner and outer zones; *s*, secretory sac; *co*, calcium oxalate crystals. × 105.

PLATE 4. ARCHANGELISIA FLAVA (LINNÆUS) MERRILL

FIG. 15. A portion of a radial section through the cortex; *s*, secretory sac; *sc*, stone cells. × 105.

16. Another portion of a radial section through the cortex; *s*, secretory sac. × 105.

17. Different types of cells isolated by Schulze's maceration process; *a*, bast fibers; *b*, wood fibers; *c*, wood parenchyma; *d*, vessels and tracheid, *e*, parenchyma cells with thick walls; *f*, medullary-ray cells; *g*, stone cells. × 105.

PLATE 5. ANAMIRTA COCCULUS (LINNÆUS) WIGHT AND ARNOTT

FIG. 18. Four short fresh stem portions, or pieces, of different diameters and a single fresh leaf beneath.

19. A photograph of a portion of a dried herbarium specimen with fruits.

PLATE 6. ANAMIRTA COCCULUS (LINNÆUS) WIGHT AND ARNOTT

FIG. 20. A diagrammatic representation of a transverse section of a young stem; *p*, periderm; *c*, cortex; *pe*, pericycle; *ph*, phloëm; *x*, xylem; *m*, medullary ray. × 7.

21. A portion of the transverse section of the periderm; *k*, cork cells; *sc*, stone cells; *phe*, phellogen. × 275.

FIGS. 22 to 24. Small segments taken from the inner portion of the cortex, representing the three early stages of the development of the secondary vascular bundles; *pr*, procambial strands; *co*, calcium oxalate crystals; *sc*, stone cells. × 165.

FIG. 25. A young secondary vascular bundle; *sc*, stone cells; *ph*, phloëm; *fc*, fascicular cambium; *wp*, wood parenchyma; *m*, medullary ray; *sg*, starch grains; *co*, calcium oxalate crystals. × 165.

PLATE 7. ANAMIRTA COCCULUS (LINNÆUS) WIGHT AND ARNOTT

FIG. 26. A portion from the middle part of the primary xylem; *v*, vessels; *wp*, wood parenchyma and wood fibers; *m*, medullary ray; *co*, calcium oxalate crystals. × 165.

27. A small portion of the pericyclic region; *s*, secretion sacs; *bf*, bast fibers. × 275.

28. A portion of the pericyclic region after secondary thickening has taken place, showing the bast-fiber region split into small groups of cells; *sc*, stone cells; *bf*, bast fibers. × 61.

29. A lower portion of the tangential section of a medullary ray; *m*, medullary-ray cells; *wp*, wood parenchyma; *co*, calcium oxalate crystals. × 165.

30. Medullary-ray cells from a transverse section of a stem; *co*, calcium oxalate crystals. × 700.

31. A small segment of a radial section through cortical region; *s*, secretory sac; *sc*, stone cells. × 105.

FIG. 32. A small portion of the outer zone of the central pith; *s*, secretory sac; *sg*, starch grains. × 105.

PLATE 8. ANAMIRTA COCCULUS (LINNÆUS) WIGHT AND ARNOTT

FIG. 33. Different forms of cells isolated by Schulze's maceration process; *a*, wood fibers; *b*, bast fibers; *c*, vessels and tracheids; *d*, parenchyma cells with thick and pitted walls; *e*, wood parenchyma; *f*, stone cells magnified. × 105.

TEXT FIGURES

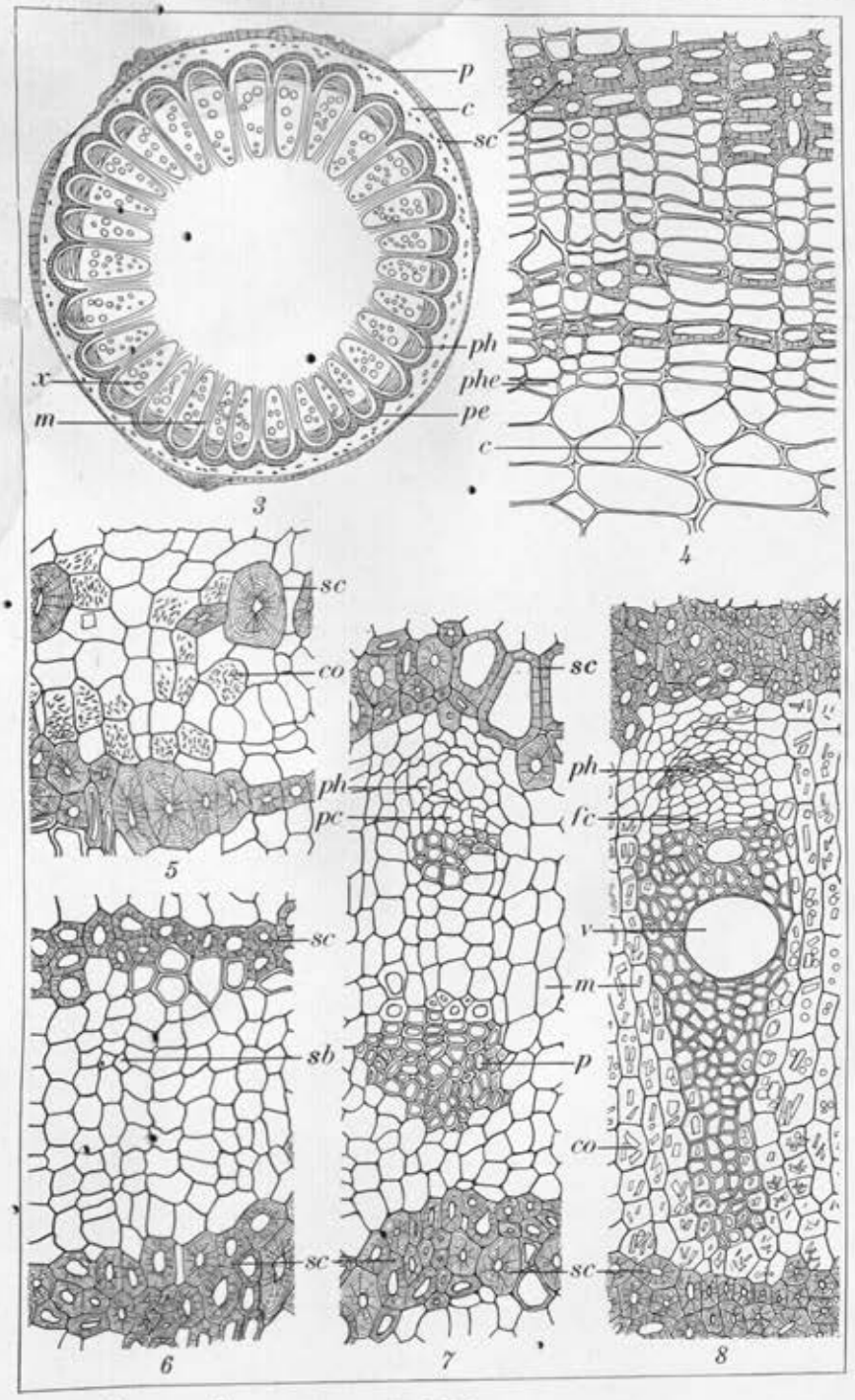
FIG. 1. A diagrammatic view of smoothly cut portion of an adult stem of *Archangelisia flava*, showing the eccentric sucessive rings of growth. × 1.5.

2. A diagrammatic camera lucida sketch of a segment of a transverse section of *Archangelisia* adult stem; *p*, periderm; *c*, cortex; *sc*, stone cells; m_1–m_4, medullary rays; vb_1–vb_4, vascular bundles; ph_1–ph_3, phloëm; *bf*, bast fibers.

3. A diagrammatic representation of the cut surface of the stem of *Anamirta cocculus*, showing the successive rings of growth. × 1.5.

4. A diagrammatic camera lucida sketch of a segment of a transverse section of *Anamirta* adult stem; *p*, periderm; *c*, cortex; *sc*, stone cells; m_1–m_3, medullary rays; vb_1–vb_4, vascular bundles; ph_1–ph_4, phloëm; *bf*, bast fibers.

PLATE 1.



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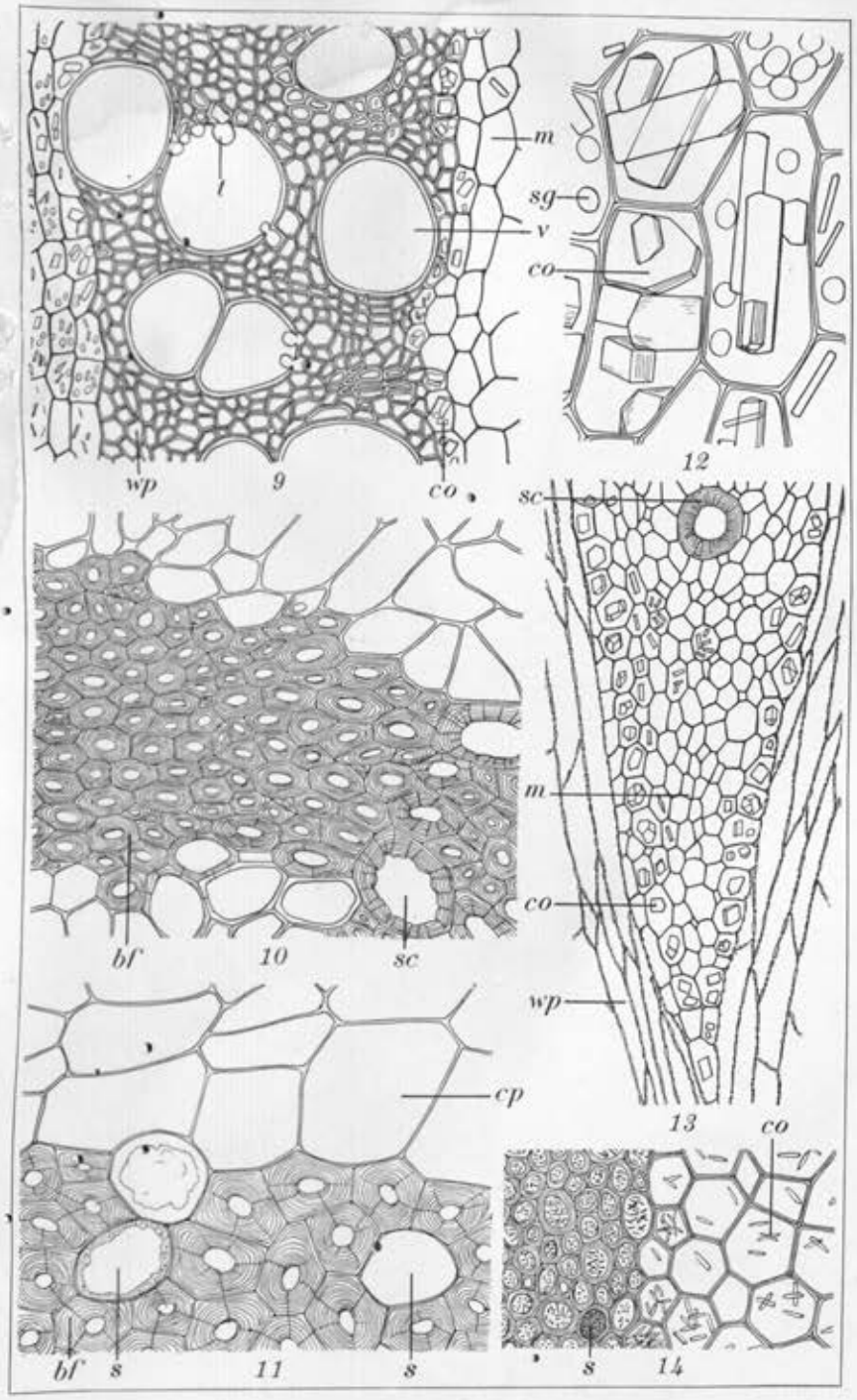

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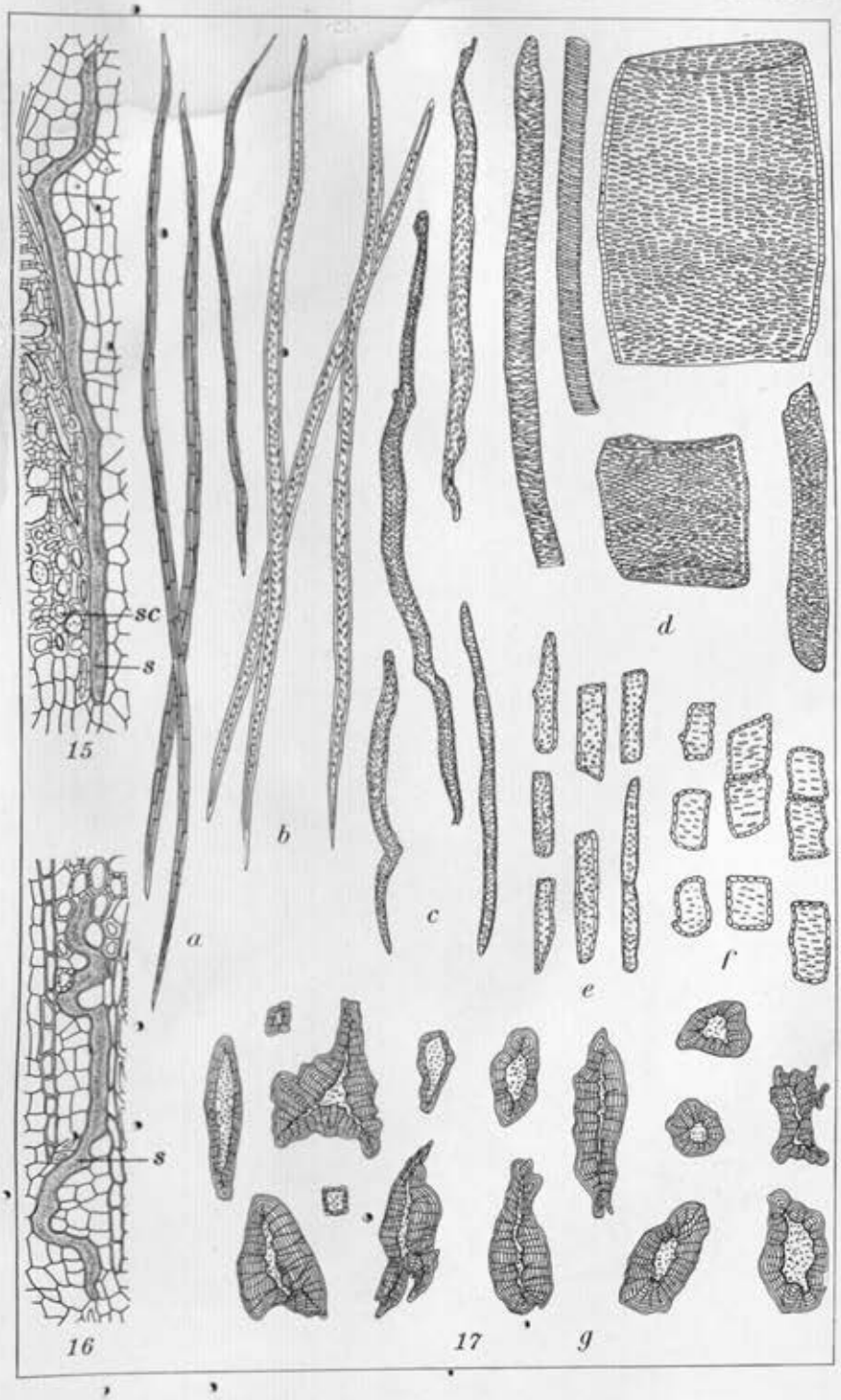

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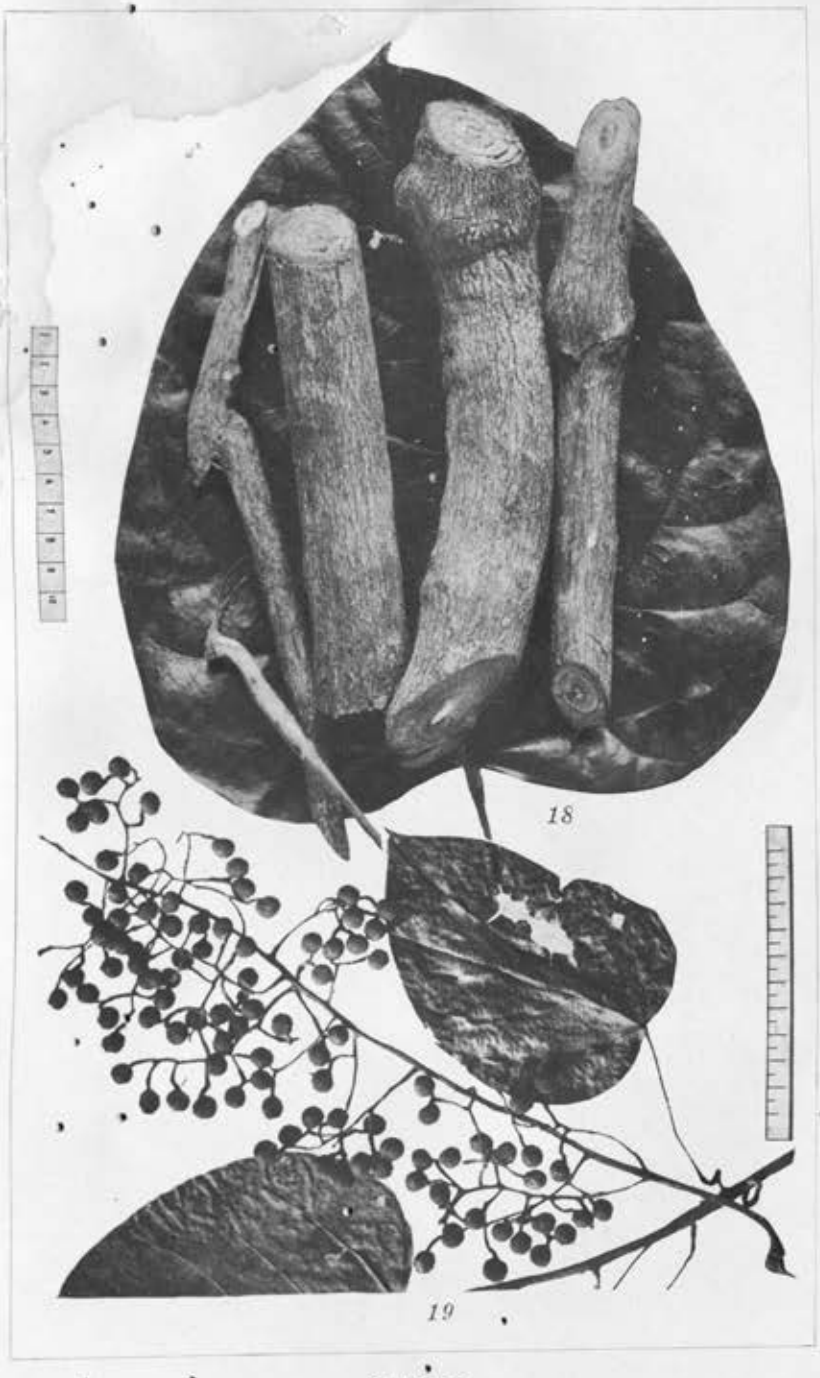

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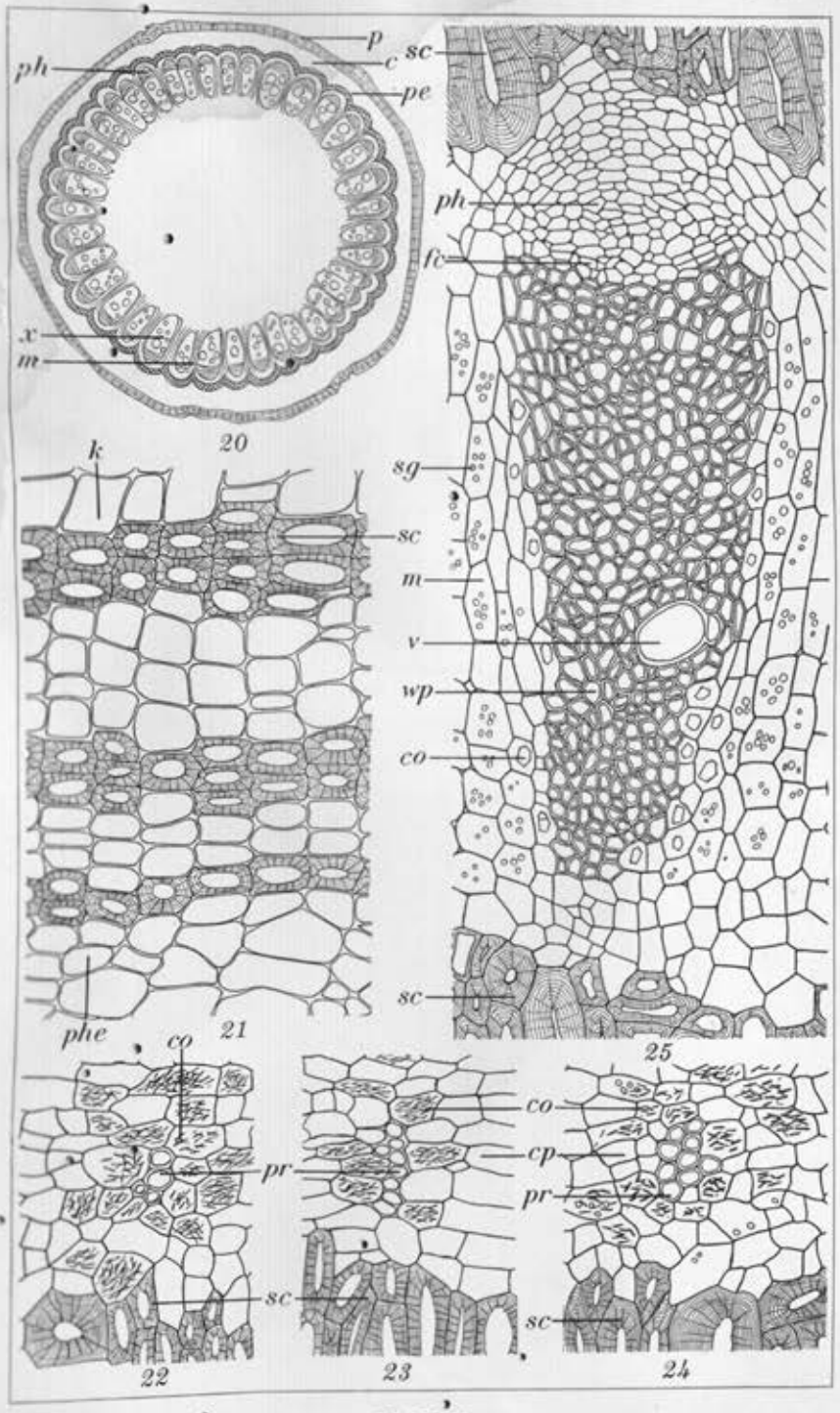
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PLATE 6.

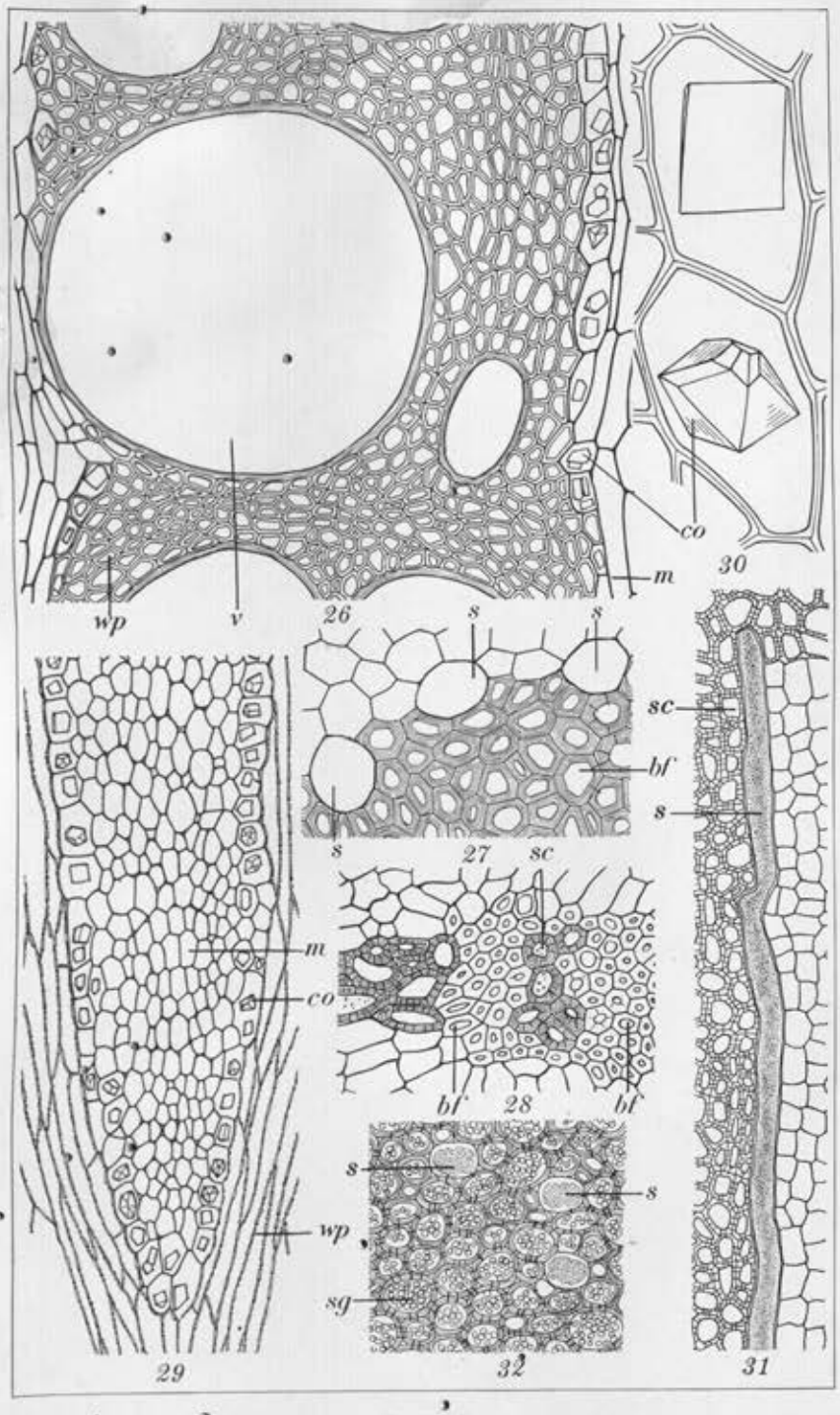

PLATE 7.

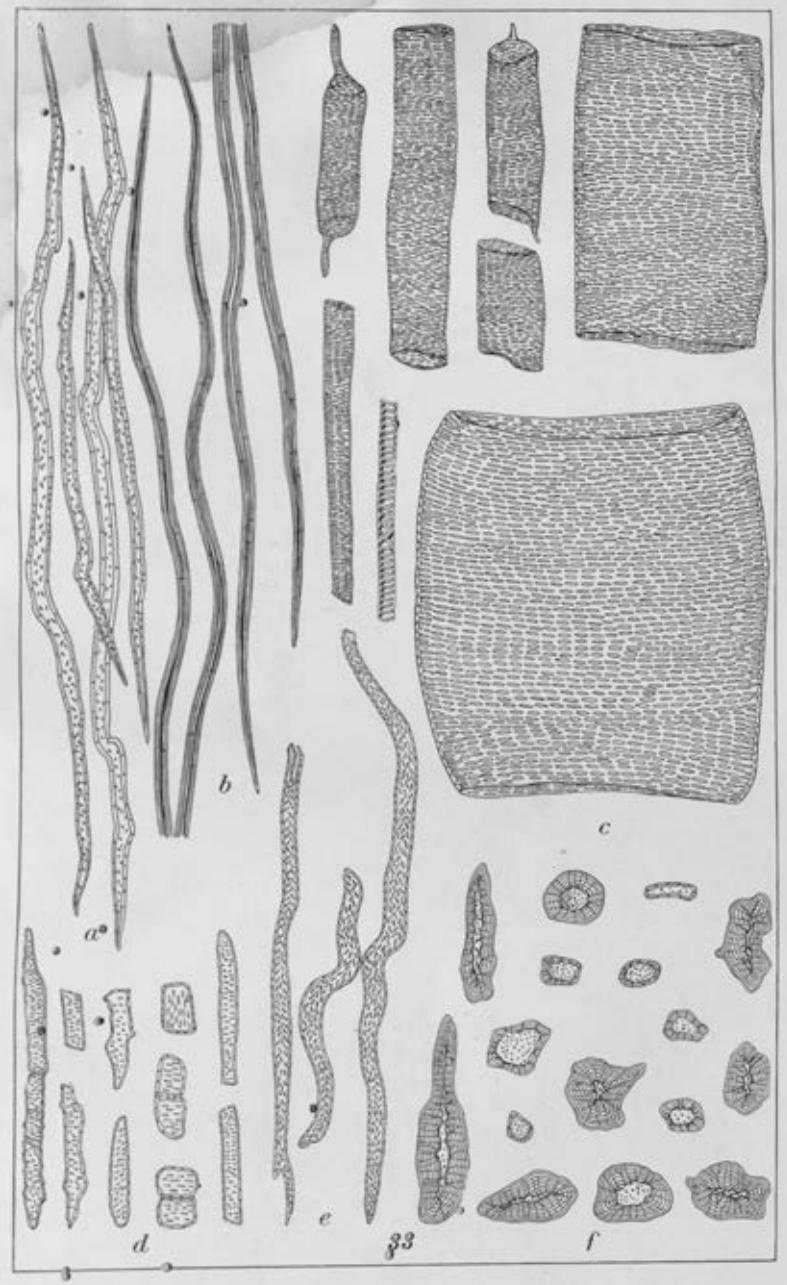

PLATE 8.

THE ISOLATION OF ANONAINE FROM ANONA SQUAMOSA LINNÆUS

By FELICIANA R. REYES and ALFREDO C. SANTOS

Of the Department of Pharmaceutical Chemistry
University of the Philippines, Manila

Anona squamosa Linnæus, commonly known as "ates," is a plant cultivated throughout the Philippines. According to Tavera [1] the powdered seeds are used to kill parasites of the human body, especially lice.

Very little is known of the chemistry of the plant. N. Trimourti [2] obtained from the leaves a white powdery base in the amount of 0.4 per cent calculated as chloroplatinate. It appears that Trimourti did not obtain the pure base.

In a recent communication, one of us [3] reported the isolation of anonaine from the bark of *Anona reticulata* Linnæus, a base melting at 122 to 123°. Based on the result of the elementary analysis, molecular-weight determinations, and the analysis of the hydrochloride and the chloroplatinate the formula $C_{17}H_{16}NO_2$ has been adopted for anonaine.

To determine the possible relation between the base of Trimourti and anonaine, the bark of *Anona squamosa* has been chemically examined and found to contain a crystalline alkaloid melting at 122 to 123°. In this communication it is further shown that this base is identical with anonaine. The melting points of the free base from *Anona squamosa* and that of anonaine as well as their hydrochlorides and chloroplatinates agree with each other. No depression was observed when the melting

[1] Tavera, T. H. Pardo de, Plantas medicinales de Filipinas. Madrid (1892) 21.

[2] Journ. Ind. Inst. 7 (1924) 232–34.

[3] Philip. Journ. Sci. 43 (1930) 561.

points of the mixed free bases, and other salts mentioned, were determined as shown in the following table:

	Anonaine from *Anona reticulata*.	Base from *Anona squamosa*.	Melting point of mixture.
	°C.	°C.	°C.
Base	122-23	122-23	122-23
Hydrochloride (decomposed)	287-88	287-88	287
Chloroplatinate (decomposed)	248.5	247	248.5

It would now be very interesting to examine *Anona muricata* Linnæus to find out the relation to anoniane of the amorphous alkaloid mentioned by Callan and Tutin.[4]

EXPERIMENTAL

For the isolation of the alkaloid the method[3] used in the isolation of anonaine from *Anona reticulata* Linnæus has been followed. Alkaloid, weighing 0.258 gram; was obtained from 1.8 kilograms of material; yield, 0.0143 per cent.

After several recrystallizations of the hydrochloride the free base was prepared and found to melt at 122 to 123°. The mixed melting point with authentic anonaine was 122 to 123°.

In the previous communication the melting points of anonaine hydrochloride and anonaine chloroplatinate as obtained from *Anona reticulata* Linnæus were not reported. These constants have been determined and are 287 to 288° for anonaine hydrochloride and 248.5° for anonaine chloroplatinate. The melting points of the hydrochloride and of the chloroplatinate of the base under examination were 287 to 288° and 247°, respectively. Mixed melting point with authentic anonaine hydrochloride and anonaine chloroplatinate gave 287° and 248.5°, respectively.

MANILA, *July 19, 1930.*

[3] Philip. Journ. Sci. 43 (1930) 561.
[4] Pharm. Journ. § IV 33 (1911) 743.

AN AUTOMATIC VACUUM PRESSURE REGULATOR [1]

By HOWARD IRVING COLE

Chief Chemist, Culion Leper Colony, Philippine Health Service

ONE TEXT FIGURE

In the course of separating the ethyl esters of hydnocarpic and chaulmoogric acids by fractional distillation, great difficulty was experienced in maintaining a constant pressure (of 20 millimeters) by means of a mercury trap. An automatic vacuum regulator was constructed to be used on a 110-volt direct current. It has now been in constant operation for two years with very satisfactory results. It will maintain a vacuum within ± 0.5 millimeter. In principle it is similar to the regulator of Miller and McKinney [2] but contains several modifications. Text fig. 1 shows a sketch of the apparatus. The pressure is determined by the difference in height of the mercury columns in tubes *a* and *b* which are in the same mercury well, *b* being a barometer.[3] Tube *a* has the same internal diameter as *b* but is constricted to 0.5 millimeter at the bottom to prevent bouncing of the column of mercury. The pressure is regulated by moving either the tube *a* or the wire *c* up or down. To prevent excessive sparking a 1-microfarad condenser is placed across the circuit between *c* and *d*. To reduce the current, a 20-watt lamp, *f*, is placed in series with the electromagnet *g*; *h* is the base of a No. 22 hypodermic needle; *i* is one-half of a No. 0 rubber stopper; *m* is a screw cock; *j* and *k* are adjustable; *l* is a piece of clock spring rivetted to *n* and screwed to a block.

OPERATION

When the vacuum becomes high enough to make contact at *c* it closes the circuit; *n* is drawn to the magnet, thus opening *h* and allowing air to enter the system. The mercury falls in *a*,

[1] Published with the approval of the Director of Health.

[2] Journ. Ind. Eng. Chem. 20 (1928) 552.

[3] By using this type of manometer corrections for temperature and capillarity can be ignored. The vacuum can be immediately adjusted to change of barometric pressure by simply maintaining the desired difference in the two columns of mercury.

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Chief Chemist, Culion Leper Colony, Philippine Health Service

ONE TEXT FIGURE

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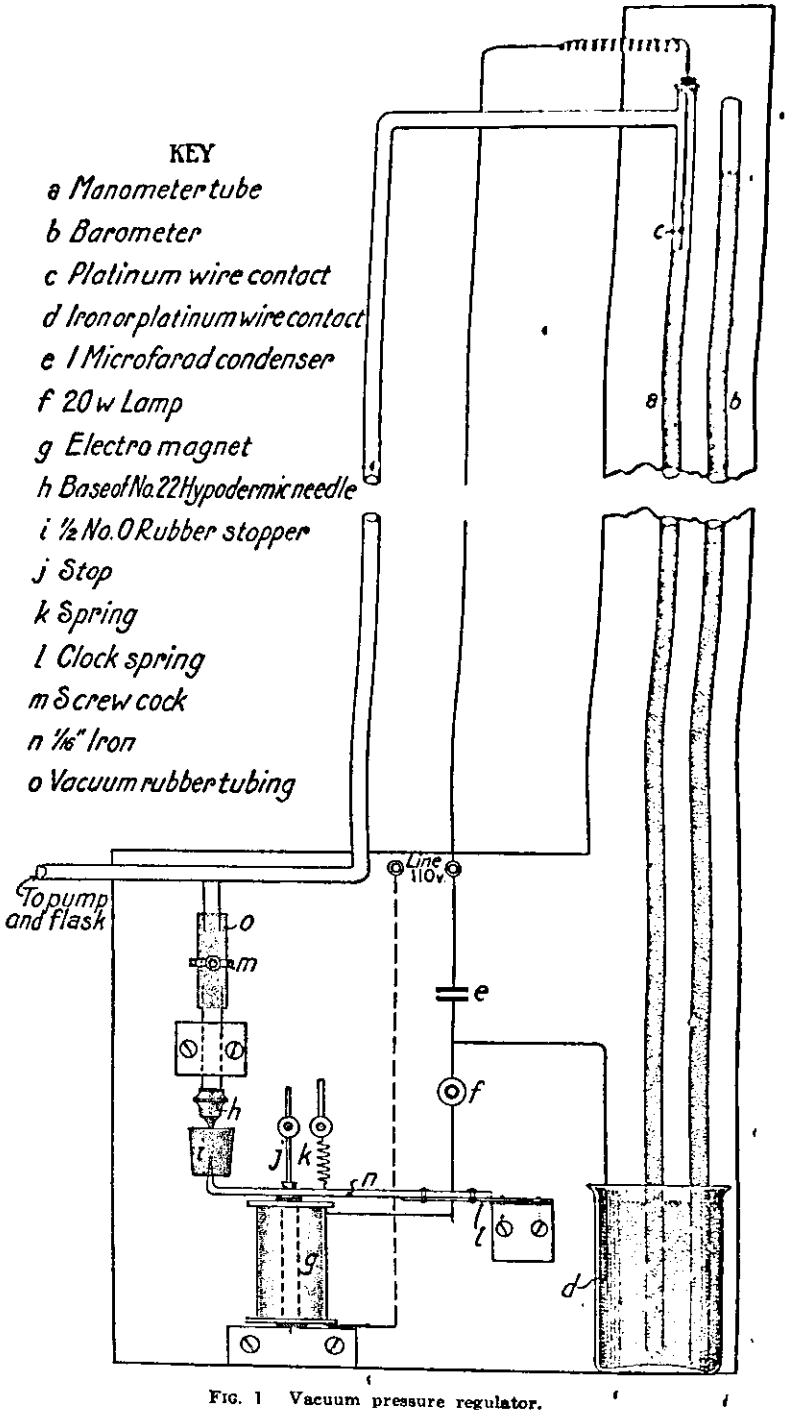

FIG. 1 Vacuum pressure regulator.

breaking the circuit, thus closing *h*. If the opening in *h* is too large, an excessive amount of air is introduced letting the vacuum fall too much. Various-sized openings were tried, but it was found that a method of regulating the amount of air introduced was necessary in any case. This is accomplished by the screw cock *m* acting on a piece of heavy vacuum rubber tubing *o*. By regulating *m* the variation in vacuum can be controlled to within less than 0.5 millimeter.

With slight modifications this apparatus can be run on a battery instead of a 110-volt direct current.

ILLUSTRATION

TEXT FIG. 1. Vacuum pressure regulator.

TREMATODE PARASITES OF PHILIPPINE VERTEBRATES, III: FLUKES FROM FISH AND REPTILES

By MARCOS A. TUBANGUI

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

ONE PLATE

FISH TREMATODE

ORIENTOCREADIUM BATRACHOIDES g. et sp. nov. Plate 1, fig. 1.

This trematode is a common parasite of the fresh-water fish *Clarias batrachus* (Hamilton-Buchanan). It is referred to the family Allocreadiidæ Stossich, 1904, emend. Winfield, 1929, because of the following characteristics: The excretory bladder is single and bag-shaped; the genital pore is directly preacetabular; the ovary is pretesticular, behind but not far from the acetabulum; the testes are proximate in the posterior half of the body; and the uterus is moderately long, extending to the posterior end of the body. As far as can be ascertained from the available literature, it cannot be assigned to any of the existing genera included in that family; hence, the new genus *Orientocreadium* is hereby proposed to receive it. It bears a certain resemblance to *Plesiocreadium typicum* Winfield, 1929, but it differs from the latter in the position of its seminal vesicle outside of the cirrus sac, the presence of a prepharynx, the shortness of the œsophagus, and in the posterior extent of the vitelline glands.

Generic diagnosis.—Allocreadiidæ: Small distomes with moderately developed suckers; oral sucker simple, subterminal; acetabulum at one-third of body length from anterior end. Cuticle provided with spines. Pharynx separated from mouth by short prepharynx; œsophagus short; intestinal cæca long, reaching to near posterior end of body. Testes median, tandem, postovarial, postequatorial; cirrus sac beside acetabulum, large, muscular, inclosing only well-developed pars prostatica and cirrus; seminal vesicle large, outside of cirrus sac; genital pore

median, directly preacetabular. Ovary median or very close to median line, between acetabulum and first testis; uterus moderately long, postequatorial, reaching to near posterior end of body; vitellaria moderately developed, extending to posterior end of body; eggs small, fairly numerous.

Type species, *Orientocreadium batrachoides* sp. nov.

Description of type species.—Body small, elongate, rounded at both ends, measuring 1.74 to 2.12 by 0.41 to 0.54 millimeters; maximum width behind equator of body, usually across testes. Cuticle armed with small spines, which become sparse posteriorly and may be absent altogether at level behind first testis. Both suckers fairly well developed and nearly equal in size; oral sucker subterminal, 0.17 to 0.19 millimeter in diameter; acetabulum 0.16 to 0.20 millimeter in diameter, at one-third of body length from anterior end, or very close to that level. Mouth subterminal, separated from pharynx by short prepharynx; pharynx 0.08 to 0.13 by 0.11 to 0.13 millimeter in size; œsophagus very short, 0.03 to 0.07 millimeter long; intestinal cæca moderately wide in diameter, reaching to posterior end of body.

Testes unequal, median, tandem, postovarial, postequatorial; first testis globular, smaller than second testis, 0.15 to 0.20 by 0.13 to 0.17 millimeter in size; second testis ovoid, 0.16 to 0.26 by 0.11 to 0.17 millimeter in size; cirrus sac large, muscular, to one side of acetabulum, 0.30 to 0.33 by 0.07 to 0.09 millimeter in size, inclosing well-developed pars prostatica and long cirrus; seminal vesicle large, 0.24 to 0.26 by 0.07 to 0.08 millimeter in size, located outside of cirrus sac. Common genital opening directly preacetabular, at or slightly to one side of median line.

Ovary oval, median, at equator of body, behind but not far from ventral sucker, 0.16 to 0.19 by 0.12 to 0.13 millimeter in size; shell gland small, to one side of median line behind ovary; Laurer's canal present; receptaculum seminis absent, próximal portion of uterus being dilated and serving as seminal receptacle; uterus moderately developed, postequatorial, extending posteriorly to near caudal end of body and laterally outside of cæca; vitellaria in follicles being often united so as to form a sort of lattice work and extending from anterior level of ovary to posterior end of body where follicles from two sides unite. Eggs fairly numerous, small, operculated, amber-yellow, 24.7 to 31.5 by 18.0 to 20.2 microns in size.

Excretory bladder simple, bag-shaped, opening outside through excretory pore at posterior tip of body.

Specific diagnosis.—Orientocreadium: Small, elongate, rounded at both ends, 1.74 to 2.12 by 0.41 to 0.54 millimeters in size; greatest diameter behind middle of body length, usually across testes; prepharynx and œsophagus both very short; testes with smooth margins, unequal in shape and size, anterior one being globular and posterior oval; seminal vesicle large, outside of cirrus sac; ovary oval; vitellaria in connected follicles extending from anterior level of ovary to posterior end of body; eggs operculated, amber-yellow, 24.7 to 31.5 by 18.0 to 20.2 microns in size.

Host.—Clarias batrachus (Ham.-Buch.).

Location.—Intestine.

Locality.—Laguna de Bay, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collections, No. 36.

REPTILIAN TREMATODES

MESOCOELIUM MEGGITTI Bhalerao, 1927. Plate 1, fig. 3.

Numerous specimens of this fluke were collected on two occasions from the small intestine of the common ground lizard *Mabuia multifasciata* Kühl. Except for minor details, they resemble the form described by Bhalerao (1927) from a Rangoon lizard, *Mabuia dissimilis,* under the name *Mesocoelium meggitti.* The differences, it is believed, are due to the age of the specimens, those of Bhalerao being apparently young mature specimens. Our Philippine material is a mixture of young and fully developed mature specimens, the former tallying with Bhalerao's description.

Description.—Body elongate, flat, broader anteriorly than posteriorly, measuring 1.02 to 3.30 by 0.36 to 1.03 millimeters. Cuticle beset with minute spines at anterior half or two-thirds of body length. Oral sucker ventroterminal, 0.14 to 0.27 millimeter in transverse diameter; acetabulum between anterior and middle thirds of body length, much smaller than oral sucker, 0.07 to 0.17 millimeter across. Mouth ventroterminal, separated from pharynx by very short prepharynx; pharynx 0.05 to 0.10 by 0.06 to 0.13 millimeter in size; œsophagus 0.02 to 0.08 millimeter long; intestinal cæca simple, terminating at level between middle and last thirds of body length or very close to that level.

Reproductive glands grouped around acetabulum. Testes oval, slightly preovarial on each side of acetabulum, the one on the same side as the ovary usually more advanced anteriorly than the other; they are nearly equal in size, measuring 0.08

to 0.17 by 0.07 to 0.12 millimeter; cirrus sac small, median, between pharynx and acetabulum, 0.25 to 0.27 by 0.04 to 0.05 millimeter in size, inclosing small seminal vesicle, pars prostatica, and cirrus. Common genital opening median or slightly to one side of median line, at middle level of œsophagus.

Ovary oval, to one side of median line, post-testicular, though often occurring almost at the same level as opposite testis, measuring 0.08 to 0.20 by 0.07 to 0.15 millimeter; shell gland appears diffuse, close to mesial side of ovary; receptaculum seminis and Laurer's canal present. Uterus mostly postovarial, reaching to near posterior end of body; occurs in two loops, each with numerous transverse loops:—a descending loop filled with colorless unripe eggs and an ascending loop filled with yellowish to dark brown mature or ripe eggs. Vitellaria in distinct follicles, extending on both sides of body from posterior level of oral sucker to near one-third the distance of body length from posterior end. Mature eggs operculated, 30 to 36 by 20 to 24 microns in size.

Excretory pore at posterior end of body; excretory bladder a narrow or dilated canal extending from excretory pore at posterior end of body to behind shell gland, where it divides into two lateral branches.

Host.—*Mabuia multifasciata* Kühl.

Location.—Intestine.

Locality.—Los Baños, Laguna Province, Luzon.

EUPARADISTOMUM VARANI g. et sp. nov. Plate 1, fig. 2.

Seven mature specimens of this parasite were collected from the gall bladder of a young chicken-eating lizard, *Varanus salvator* Linn., which was caught near Molawin Creek, Los Baños, Luzon, November 17, 1929. In the fresh state, they closely resemble members of the genus *Paradistomum*, but a study of the internal anatomy after the flukes had been stained and mounted, revealed the following differences, which appear sufficiently important to place the species in a new genus in the trematode family Dicrocœliidæ Odhner, 1911: (*a*) The testes, instead of being behind the acetabulum, as is usually the case among the members of the family Dicrocœliidæ, are located anterior of that organ; (*b*) the uterine coils are very profuse, being distributed throughout most of the body substance; (*c*) the acetabulum is equatorial in position; and (*d*) the cirrus sac is far behind the pharynx, being located at a level about equidistant between that organ and the ventral sucker.

Generic diagnosis.—Dicrocœliidæ: Body relatively broad and flat, attenuated at both ends. Cuticle smooth. Acetabulum at or very close to equator of body, weaker than oral sucker. Genital pore median, far in front of acetabulum. Testes symmetrical, directly preacetabular; cirrus sac small, about midway between two suckers. Ovary close to median line, directly postacetabular; receptaculum seminis small; uterine coils profusely distributed throughout most of body substance, not clearly arranged into ascending and descending loops; vitellaria moderately developed, extracæcal. Excretory bladder Y-shaped.

Type species, *Euparadistomum varani* sp. nov.

Description of type species.—Body relatively broad, flat, more pointed posteriorly than anteriorly, 2.0 to 2.9 by 1.3 to 1.7 millimeters in size. Cuticle smooth. Oral sucker subterminal, 0.69 to 0.79 millimeter in transverse diameter; acetabulum at or very close to equator of body, smaller than oral sucker, 0.35 to 0.45 millimeter across. Mouth subterminal; prepharynx absent; pharynx 0.19 to 0.21 by 0.22 to 0.24 millimeter in size; œsophagus 0.15 to 0.20 millimeter long, bifurcating at level about midway between genital pore and pharynx; intestinal cæca much dilated, not quite reaching to caudal end of body.

Testes small, oval, with smooth margins, symmetrical, intercæcal, directly preacetabular, measuring 0.24 to 0.28 by 0.14 to 0.22 millimeter; cirrus sac small, elongated, 0.23 by 0.07 millimeter in size, in median line about equidistant between oral and ventral suckers, inclosing slightly coiled seminal vesicle, pars prostatica, and protrusible cirrus. Common genital opening behind œsophageal bifurcation.

Ovary oval, with smooth borders, slightly larger than testes, 0.24 to 0.31 by 0.15 to 0.20 millimeter in size, directly postacetabular, close to median line; shell gland distinct, median, near posteromesial border of ovary; receptaculum seminis small, Laurer's canal present; uterine coils very profusely distributed throughout most of body substance, not clearly arranged into ascending and descending loops; vitellaria moderately developed, in lateral margins of body, extracæcal, extending from posterior level of cirrus sac to termination of intestinal cæca or slightly beyond that level. Mature eggs amber yellow, operculated, with a sort of neck below the operculum, measuring 39.5 to 45.0 by 22.5 to 24.7 microns.

Excretory bladder Y-shaped; excretory pore at posterior tip of body.

Specific diagnosis.—Euparadistomum: Body broad, flat, attenuated at both ends, but more pointed posteriorly, 2.0 to 2.9 by 1.3 to 1.7 millimeters in size; cuticle smooth; acetabulum at equator of body; cirrus sac small, in median line about midway between suckers; testes oval, symmetrical, directly preacetabular; ovary directly postacetabular, close to median line; uterus very well developed and distributed throughout most of body substance; vitellaria extracæcal, extending from posterior level of cirrus sac to termination of intestinal cæca or slightly beyond that level; eggs numerous, operculated, with distinct necks, 39.5 to 45.0 by 22.5 to 24.7 microns in size.

Host.—Varanus salvator Linn.

Location.—Gall bladder.

Locality.—Los Baños, Laguna Province, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collections, No. 37.

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WINFIELD, G. F. Plesiocreadium typicum, a new trematode from Amia calva. Journ. Parasit. 16 (1929) 81–87.

ILLUSTRATIONS

[The lettering of the figures in this and in future papers on Philippine trematodes will be similar to that used in Trematode parasites of Philippine vertebrates, II, See Philippine Journal of Science 44 (1931).]

PLATE 1

FIG. 1. *Orientocreadium batrachoides* g. et sp. nov., ventral view. (Drawing by M. Ligaya.)

2. *Euparadistomum varani* g. et sp. nov., ventral view.

3. *Mesocoelium meggitti* Bhalerao, 1927, ventral view.

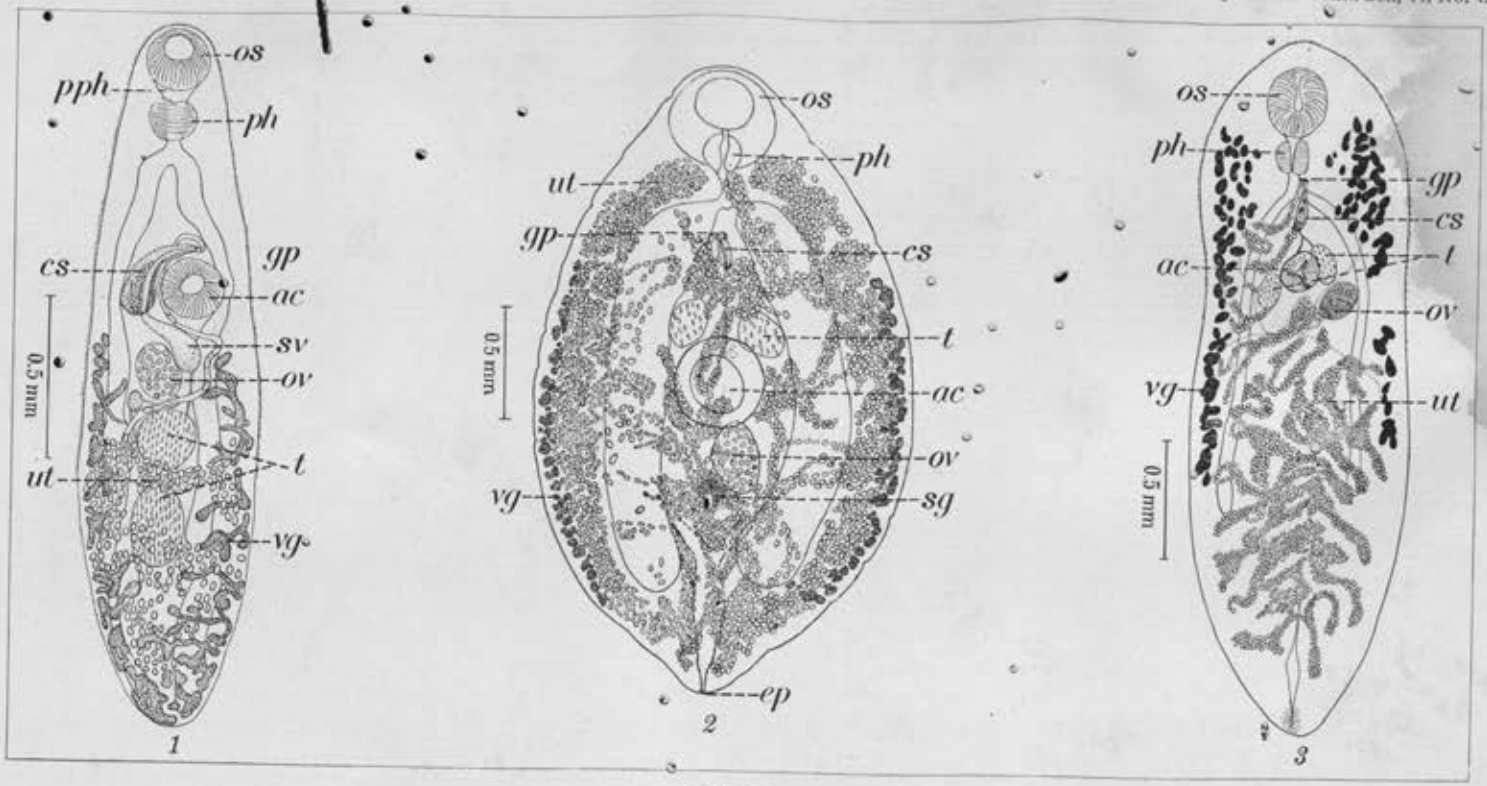
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PLATE 1.

THE BARBIROSTRIS-HYRCANUS GROUP OF THE PHILIPPINE ANOPHELES[1]

By F. E. BAISAS

Of the Philippine Health Service, Manila

THREE PLATES AND SEVEN TEXT FIGURES

The present paper is one of a series of studies the malaria division of the Philippine Health Service is undertaking in an effort to bring the Philippine anophelines to a standard method of classification. We find that the Philippine species do not conform exactly in all details with the various descriptions given by different authors on Oriental anopheles. We are handicapped, moreover, by the lack of materials from other countries, with which to compare our own.

The specimens dealt with in this study were collected in and around Calauan, Laguna, Luzon, from the latter part of May to the earlier part of August, 1929, and in and around Tungcong Manga, San Jose, Bulacan, Luzon, during September and October of the same year. This period covered the last part of the dry season and almost the whole of the rainy season. The mounted adults as well as their larval and pupal skins, which were mounted in Gater's fluid,[2] are deposited in the Philippine Health Service, Manila.

Grateful acknowledgment is hereby expressed to Dr. C. Manalang, my immediate chief, for valuable suggestions, for correcting and editing this paper, and for the benefit of his wide experience; and to Dr. W. V. King, of the United States Bureau of Entomology, under whom the whole technic and systematic isolation and follow-up of individual insects from larva to adult have been learned and are here employed. Thanks are also due to Dr. G. Villanueva, of malaria-control unit No. 1, and to his men, Messrs. M. Serrano and A. Bagabaldo, for laboratory help and field collections. I also owe a great deal to the field labor-

[1] From the field laboratory, division of malaria control, Philippine Health Service, Tungcong Manga, San Jose, Bulacan Province, Luzon. Submitted for publication November, 1929.

[2] Bull. Ent. Res. 19 pt. 4 (1929) 367-368.

atory personnel at Tungcong Manga for company and help. I also thank Dr. Paul F. Russell, of the Rockefeller Foundation, for the free access given me to his personal library and for his kindness in reading this manuscript.

REVIEW OF LITERATURE

There seems to be a general agreement among authors relative to *Anopheles barbirostris* van der Wulp. In the Philippines no other species has been mistaken for it or a synonym credited under this *Anopheles*. Ludlow [3] was the first to report the existence of this mosquito in the Archipelago, followed by Banks,[4] Bezzi,[5] Barber and Walker,[6] Dyar,[7] and Tiedeman.[8] S. R. Christophers [9] could not ascertain from the specimens in the British Museum whether Walker's *vanus* was *barbirostris* or *bancrofti*. "If shewn with certainty to be either," he says, "it would have precedence." N. H. Swellengrebel and J. M. H. Swellengrebel de Graaf [10] reported a variety of *barbirostris* (var. *pallidus*) in Netherlands India, which was later recorded as a distinct species under the name *barbumbrosus* by Strickland.[11] Both *pallidus* and *barbumbrosus* as described by Swellengrebel and Swellengrebel de Graaf [12] and by Strickland and Chowdhury,[13] respectively, differ from the type form (that is, *barbirostris*) only in that the outer anterior clypeal hair has fewer branches (eleven to twenty-two as against sixty or more of the type) than that of typical *barbirostris*. The smallest number of twigs in our series was of those collected with *leucosphyrus* Donitz in a mountain creek at the College of Agriculture, near Los Baños. They vary from twenty to twenty-five or more. Examination of the mesosome and its leaflets showed this kind to be identical with *barbirostris*. In the matter of the number of branches, therefore, of the outer anterior clypeal hair of *barbirostris* in our collections, the range of twenty to forty or an average of thirty each does not fall quite as low as those

[3] Can. Entom. 37 (1905) 135.
[4] Philip. Journ. Sci. 1 (1906) 981.
[5] Philip. Journ. Sci. § D 8 (1913) 306.
[6] Philip. Journ. Sci. § B 9 (1914) 389.
[7] Insecutor Inscitiae Menstruus 8 Nos. 10–12 (1920) 184–186.
[8] Journ. Prev. Med. 3 (1927) 227.
[9] Prov. List and Ref. Cat. of the Anoph. (1924) 32.
[10] Bull. Ent. Res. 11 (1920) 82.
[11] As cited by Chowdhury in Ind. Journ. Med. Res. 16 No. 4 (1929) 988.
[12] Bull. Ent. Res. 11 (1920) 82.
[13] The Anoph. Larvae of India, Ceylon and Malaya (1927) 32, pl. V, D.

of *barbumbrosus* or as high as those of *barbirostris* in the countries represented by the works of the above-cited authors. Christophers [14] considers *pallidus* (and, for that matter, probably *barbumbrosus,* which is not mentioned in his provisional list) synonymous with *bancrofti.*

In a recent publication,[15] Chowdhury described a "new variety of proto-anopheline *A. barbirostris* v. d. Wulp var. *ahomi* found in Upper Assam." Judging from his description and the illustration of the head of the larva, his *ahomi* falls well within what we are calling *A. pseudobarbirostris* Ludlow, in this paper. He says, "Clypeal hairs:—anterior internal long, straight, and has several branches on its distal half; anterior external dendriform branching with more than 50 to 60 twigs; posterior short, straight and usually bifid, but simple and trifid hairs have also been found." Unfortunately, he does not give a full description of the adult,[16] and even the lateral hairs and Martini's hair No. 5 of the sixth abdominal segment, and the stigmal plate of the larva have not been discussed, so we are left to suppose that *ahomi, pseudobarbirostris,* and *bancrofti* are varieties of one species, if not actually the same species.[17]

Christophers has this to say of *bancrofti* larva: ". . . outer anterior clypeal hair formed of about 17 branches only," and of its adult, ". . . legs flecked with scattered white scales; white scales present distal to black ventral tuft; center of mesepimeron devoid of white scales." The points cited for the adult agree with those of our *pseudobarbirostris,* but the outer anterior clypeal hairs of all the larvæ from which they were bred out had numerous close set branches running up to sixty or more each (see fig. 1, 3). In fact this species can be distinguished from *barbirostris* or the varieties of *hyrcanus* in the larval form by the peculiar pattern of this hair. *Anopheles bancrofti* has been differentiated from *barbirostris* by Giles [18] in the following man-

[14] Prov. List and Ref. Cat. Anoph. (1924) 32.

[15] Ind. Journ. Med. Res. 16 No. 4 (1929) 988.

[16] He merely mentioned that the male genitalia of *ahomi* showed characters similar to those of typical *barbirostris,* except in the thecal leaflets, which are rather longer and more regular in arrangement on the thecal knob than in the type species.

[17] Prov. List and Ref. Cat. of the Anoph. (1924) 32. F. W. Edwards, Bull. Ent. Res. 14 (1924) 353, says: "*A. pseudobarbirostris* Ludlow from the Philippines has legs similar to those of *A. bancrofti* and also agrees in hypopygeal structure." It seems justifiable, however, to retain *pseudobarbirostris,* provisionally, because of the difference in the larval forms.

[18] Handb. of Gnats or Mosq. ed. 2 (1902) 511.

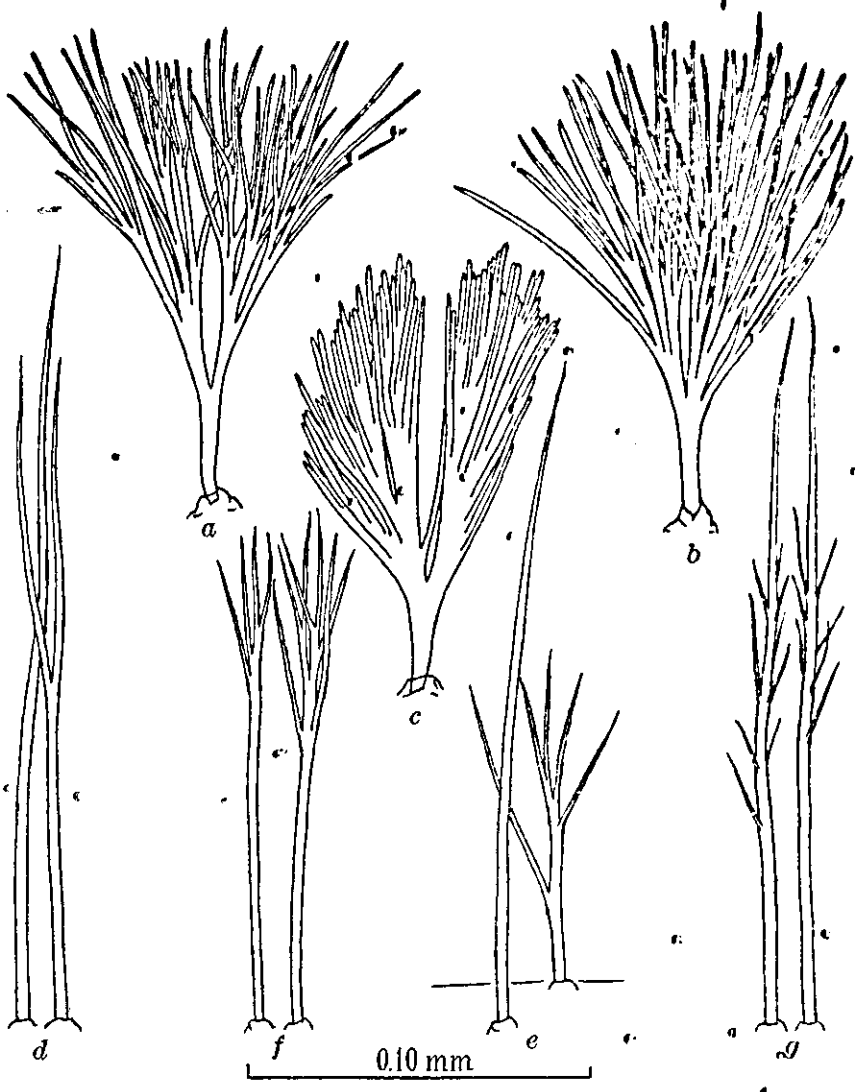

FIG. 1. Anterior clypeal hairs in *Anopheles; a, Anopheles barbirostris* van der Wulp, outer anterior clypeal hair; *b, Anopheles hyrcanus* var. *sinensis* Wiedeman, outer anterior clypeal hair; *c, Anopheles pseudobarbirostris* Ludlow, outer anterior clypeal hair; *d, Anopheles barbirostris* van der Wulp, inner anterior clypeal hairs; *e, Anopheles barbirostris* van der Wulp, inner anterior clypeal hairs (unusual); *f, Anopheles hyrcanus* var. *sinensis*, inner anterior clypeal hairs (uncommon); *g, Anopheles pseudobarbirostris* Ludlow, inner anterior clypeal hairs.

ner: "Much resembles *A. barbirostris* v. d. Wulp, but differs in the inner part of the wing being altogether darker and more densely scaled; in the second pale spot being absolutely on the

apex in place of sub-apical; and in the banding of the tarsi being much less obvious. In reality, the form is, I think, more nearly allied to *atratipes* Skuse." The wing markings of Philippine *barbirostris* and *pseudobarbirostris* show a general likeness, and vary on similar points; while the rings of the fore and hind tarsi have about the same average measurement. *Anopheles pseudobarbirostris* shows the apical and basal rings of the fourth, and the basal ring of the last tarsi of the hind legs in a much greater frequency and more marked than those of *barbirostris*.

Carter [19] also used *pseudobarbirostris* in naming two specimens (the only ones he has), the larvæ of which he did not see.

Heretofore, we used *hyrcanus* Pallas for *hyrcanus* var. *sinensis*. W. D. v. Tiedeman [20] and others [21] used the latter. Dr. W. V. King also believed that *sinensis* was correct, so we shall employ that designation in this paper.

Carter seems to take *sinensis* as a synonym of *hyrcanus*.[22] James and Liston retracted what they named *hyrcanus* [23] var. *nigerrimus* (not *nigerrimus* Giles), and sunk it under *sinensis* Wiedeman, to which Theobald acceded. *Anopheles nigerrimus* Giles is said to differ from *sinensis* only in having black-tipped palpi. Giles was apparently willing (so said James and Liston) [24] to regard his *nigerrimus* as a specimen of *sinensis*, but Theobald opposed this and treated it as a distinct species. No other specimen of this kind has been found, and James and Liston asserted that either Giles wrongly described his specimen or that it was an extremely rare variety.

Christophers provisionally placed *sinensis* Wiedeman and *nigerrimus* Giles as the Oriental varieties [25] of *hyrcanus*. Borel's [26] illustration of his *nigerrimus* Giles has the palpi white-tipped and so should be regarded as *sinensis* Wiedeman. His description, as very kindly translated by Dr. L. Lopez-Rizal, does not mention whether or not this organ is white-tipped. Some workers

[19] The Anoph. Mosq. of Ceylon, pt. 1 (1924) 31–32.
[20] Journ. Prev. Med. 3 (1927) 227.
[21] See footnotes 3, 4, 5, and 6.
[22] The Anoph. Mosq. of Ceylon, pt. 1 (1924) 31.
[23] The Anoph. Mosq. of India, ed. 2 (1911) 15.
[24] Loc. cit.
[25] His statement on page 29 is apparently in conflict with that on page 86 (see footnote 9). It is presumed that he meant the latter.
[26] Archives des Inst. Pasteur D'Indochine, 29 and pl. 3.

placed *vanus* Walker (considered either *barbirostris* or *bancrofti* by Christophers,[27]) among the varieties of *hyrcanus*.[28]

The fringe spot opposite the posterior branch of the fifth wing vein has been found only twice in our *sinensis*. The inner anterior clypeal hairs of *sinensis* larva are pictured with fine-branching by both Theobald [29] and Martini.[30] When this hair is branched in the Philippine *sinensis* the twigs are rather coarse as in fig. 1, *f*.

The field laboratory at Tungcong Manga was occupied at an opportune time as it coincided with the breeding season of a certain variety of *hyrcanus* found only in rice fields and in the newly locked La Mesa Dam. This kind was not encountered during the stay in Calauan. Although its adult does not agree with *paeditaeniatus* Leicester [31] it is undoubtedly the Philippine representative of that species. G. E. Brooke [32] sank *paeditaeniatus* under *vanus*. He distinguished *sinensis* by the apical bands of the tibia and the first four tarsals of the hind legs, from *vanus* which has basal bands to the tibia and all the tarsals. In F. W. Edwards's opinion [33] *hyrcanus* should be substituted for *sinensis*. Later he discussed [34] the varieties of this species, stating, among others, that there is a darker variety throughout the Oriental Region, and still another, *pseudopictus*, having somewhat marked, but very variable and sometimes inconspicuous tarsal bandings. The latest suggestions he has made [35] to assist in distinguishing the chief local varieties are as follows:

I. for *sinensis*.

Hind tarsi with narrow pale rings at apices of segments only. Wings usually paler than other varieties, dark area variable and sometimes suffused, but dark spot near base of fifth vein short, usually dotlike.

[27] Prov. List and Ref. Cat. of the Anoph. (1924) 32.

[28] Ludlow, Bull. Ent. Res. 19 pt. 4 (1929) 367–368, credited the Philippines with *vanus* Walker and said it closely resembled *sinensis*. James and Liston, The Anoph. Mos. of India, ed. 2 (1911) 15, received specimens named *vanus* Walker by other workers, which they subsequently renamed *sinensis* Wiedeman.

[29] A Monograph of the Culicidae of the World 3: 18.

[30] Zool. Jahrb. Abeit. fur Sust. Geog. un Bio. der Tiere 46 (1922–23) 539.

[31] The Culicidae of Malaya F. M. S. (1908) 31.

[32] The Identification of Malayan Culicidae (1921) 49.

[33] Bull. Ent. Res. 10 (1920) 129.

[34] Bull. Ent. Res. 12 (1922) 275.

[35] Bull. Ent. Res. 20 (1929) 324.

II. for *nigerrimus* Giles (*paeditaeniatus* Leicester).
Rings of hind tarsi broader, the fourth segment more or less conspicuously white at base as well as at the tip. General color of body much blacker than in other varieties.

The material from which Edwards drew his conclusions included some specimens from the Philippines. Obviously, the black-tipped palpi of Giles's *nigerrimus* is not considered a definite characteristic by him. However, he said that if Leicester's assertion that *paeditaeniatus* larvæ constantly differed from those of *hyrcanus* (*sinensis*), was correct, the two might be considered distinct species. In this particular case Strickland [36] surmised that there might be a larval form intermediate between *sinensis* and *paeditaeniatus* just as there are imagines having characters intermediate between the two. For this reason he did not give *paeditaeniatus* even a varietal status. Christophers gave it a provisional varietal rank.[37]

The larva of the Philippine variety is so like that of *sinensis* that Strickland's presumption is quite correct, although the adults of the Philippine variety, so far as we have seen, invariably differ from those of *sinensis*. My option is to accept Edwards's opinion. Objection to this may, of course, be raised. There are, for instance, *maculatus* and *karwari*, which are accepted as distinct species, although their larvæ differ only in the mere form of the filaments of the leaflets of the abdominal palmate, which difference is sometimes not at all obvious, etc. Still, Edwards's opinion seems to be the least confusing.

DESCRIPTION OF SPECIMENS

THE LARVÆ

In Calauan, Laguna, *Anopheles barbirostris, pseudobarbirostris,* and *hyrcanus* var. *sinensis* were found breeding together in only two places; namely, a large impounded spring full of aquatic vegetation, and a small lake more thickly vegetated. They were associated with numerous larvæ of *A. philippinensis* Ludlow, more numerous (in the former place only) *minimus* Theobald, a few *subpictus* Grassi, and still fewer *A. fuliginosus* Giles. *Anopheles pseudobarbirostris* and *sinensis* were present in good numbers, but *barbirostris* was rather scarce. On the other hand, *barbirostris* was plentiful in rivers and streams and in a well, wherein bred none of the other two. Instead it was

[36] Bull. Ent. Res. 4 (1914) 135.
[37] Prov. List and Ref. Cat. of the Anoph. (1924) 29.

found in company with *minimus*, and in one mountain creek with *A. leucosphyrus* Donitz. In Tungcong Manga, *hyrcanus* var. *nigerrimus* was found associated with many *fuliginosus* and *philippinensis* and some *barbirostris* larvæ in rice fields, and only with *fuliginosus* in La Mesa Dam. No *sinensis* or *pseudobarbirostris* was found in any of the breeding places around Tungcong Manga and its vicinity.

The three distinct species are not difficult to distinguish. In fact more or less accuracy can be attained even with the naked eyes alone, although this method needs some practice and is not recommended for beginners. It must be admitted, however, that *sinensis* and *nigerrimus* would be hard to differentiate if they happened to breed together. The inner anterior submedian thoracic hair of *nigerrimus*, when having only two divisions, has the forking point usually at the middle or subbasally and sometimes subapically; and when branched into three, the branches form a characteristic tripodal arrangement (see fig. 2, *g*).[38] Actual measurement shows that it tends to be shorter than that of *sinensis*, in spite of the fact that its larva generally is much larger than that of the other. The measurement of the antennæ is also of some help. The antenna of the largest *sinensis* larva is only 0.28 millimeter long, while that of the smallest *nigerrimus* measures 0.30 millimeter. The usual antennal length of the former is 0.25 millimeter, and of the latter, 0.32 millimeter. Such differences, depending upon micrometric measurement, are, I think, of doubtful value, and hard to apply in routine work when hundreds of actively moving larvæ are to be examined.

Anopheles barbirostris.—It has long been established by workers in other countries that the principal key in differentiating the larva of *barbirostris* from that of *hyrcanus* and its varieties is the branching of the inner anterior submedian thoracic hairs. We have this in our *barbirostris* collections varying in number from four (see fig. 2, *b*) to fifteen (fig. 2, *h*, is an example of one having branches above ten in number). Swellengrebel and Swellengrebel de Graaf[39] have this hair branched as low as three in their series. The position of the antennal hair

[38] It should be remarked in this connection that "basally," "subbasally," etc., are here used with diffidence, there being instances when one term supposed to be confined to one species is also applicable to another. Thus, for instance, there are specimens of *sinensis* having one of the branches close to the base and of *pseudobarbirostris* having only truly apical branches.

[39] Bull. Ent. Res. 11 (1920) 82.

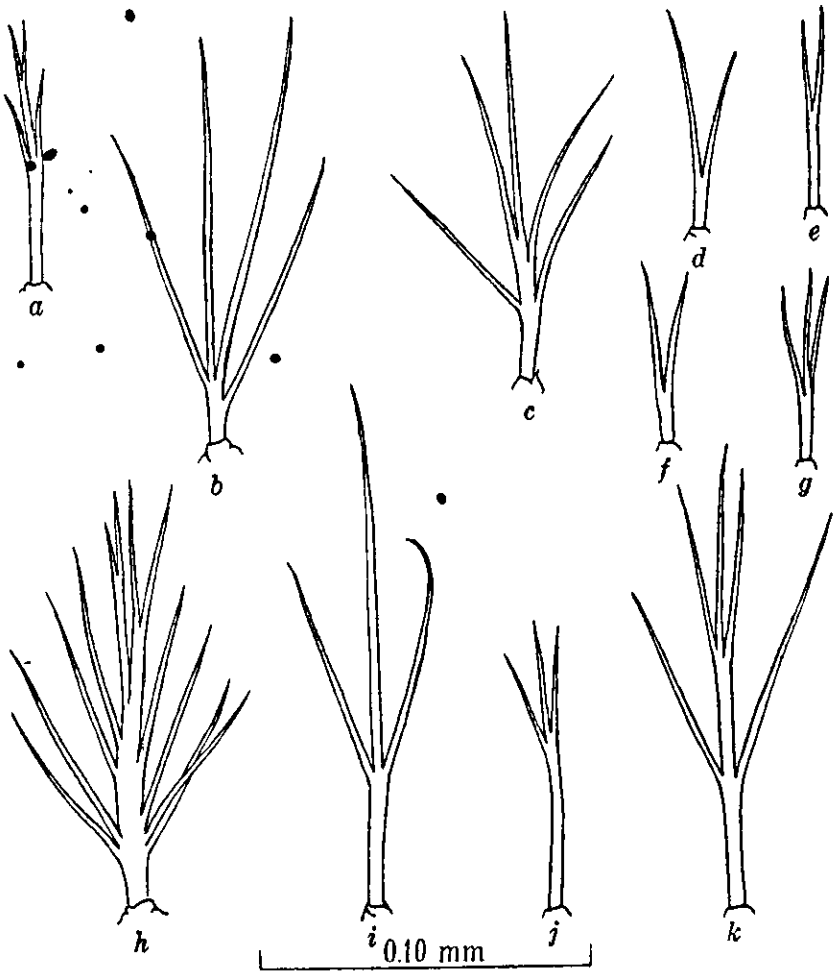

FIG. 2. Inner anterior submedian thoracic hairs in *Anopheles*; *a* and *j*, *Anopheles hyrcanus* var. *sinensis* Wiedeman; *b*, and *h*, *Anopheles barbirostris* van der Wulp; *c*, *i*, and *k*, *Anopheles pseudobarbirostris* Ludlow; *d*, *e*, *f*, and *g*, *Anopheles hyrcanus* var. *nigerrimus* Giles.

in *barbirostris* is quite constantly around one-third from the base of the antennæ while those of *pseudobarbirostris* and *hyrcanus* varieties, *sinensis* and *nigerrimus*, are at about the basal half or less. Other characteristics of aid in identification are the following:

(*a*) Inner anterior clypeal hairs simple, or one or the other, very seldom both, forked (see fig. 1, *d*).[40] A peculiar abnormality rarely seen is as shown in fig. 1, *c*.

[40] The accompanying drawings were all traced with the aid of a camera lucida by the writer.

(*b*) Outer anterior clypeal branched as in fig. 1, *a*, very often less in number than that of either *hyrcanus* varieties or *pseudobarbirostris*.

(*c*) Postclypeal hairs usually branched, the branches being closely appressed to the main stem and are not truly basal.

(*d*) Inner and outer occipital hairs averaging 10 and 9.6 branches each, respectively.

(*e*) Antennæ ranging from 0.25 to 0.35 millimeter long, with an average of 0.30 millimeter. The antennal hair has fewer branches, eight on the average, than that of *pseudobarbirostris* or of *sinensis*.

(*f*) Inner anterior submedian thoracic as above stated.

(*g*) Antepalmate hairs [41] of the fourth and fifth abdominal segments usually forked at the middle (see fig. 3, *b*).

(*h*) Lateral hairs of the sixth abdominal segment very short, less than half the length of those on the preceding two segments (fig. 3, left side, *a*).

(*i*) Hair No. 5 (Martini's) present on the sixth abdominal segment (fig. 3, left side, *d*).

(*j*) No club-shaped projection between the stigmata (fig. 5, *c*).

Anopheles pseudobarbirostris.—Under the microscope, the larva of *A. pseudobarbirostris* Ludlow has very definite distinguishing characteristics which render it easily recognized. These may be summed up as follows:

(*a*) Inner anterior clypeal hairs finely branched (fig. 1, *g*).

(*b*) Outer anterior clypeal hairs with numerous close-set branches as in fig. 1, *c*.

(*c*) Postclypeal short, usually simple.

(*d*) Inner and outer occipital hairs averaging 10 and 6.9 branches each, respectively.

(*e*) Antennæ ranging in length from 0.30 to 0.35 millimeter. The antennal hair arises at about the basal half and contains more branches than that of *barbirostris* (average 16.5).

(*f*) Inner anterior submedian thoracic branched at the middle or subapically from two to five, usually only three. It is so very much longer and stouter than that of *sinensis* or *nigerrimus* that although they may be similar in the number and position of branches one cannot be mistaken for the other (see figs. 2, *c*, *i*, *k*).

(*g*) Antepalmate of the fourth and fifth abdominal segments usually branched apically (figs. 3 and 4, right side, *b*).

(*h*) Lateral hairs on the sixth abdominal segment long, developed. On the seventh shorter but also developed (figs. 3 and 4, right side, *a*).

(*i*) Hair No. 5 on segment six absent (figs. 3 and 4, right side).

(*j*) Stigmal club present (fig. 5, *b*).

[41] Russell, P. F., Am. Journ. Hyg. 5 No. 2 (1925) 166.

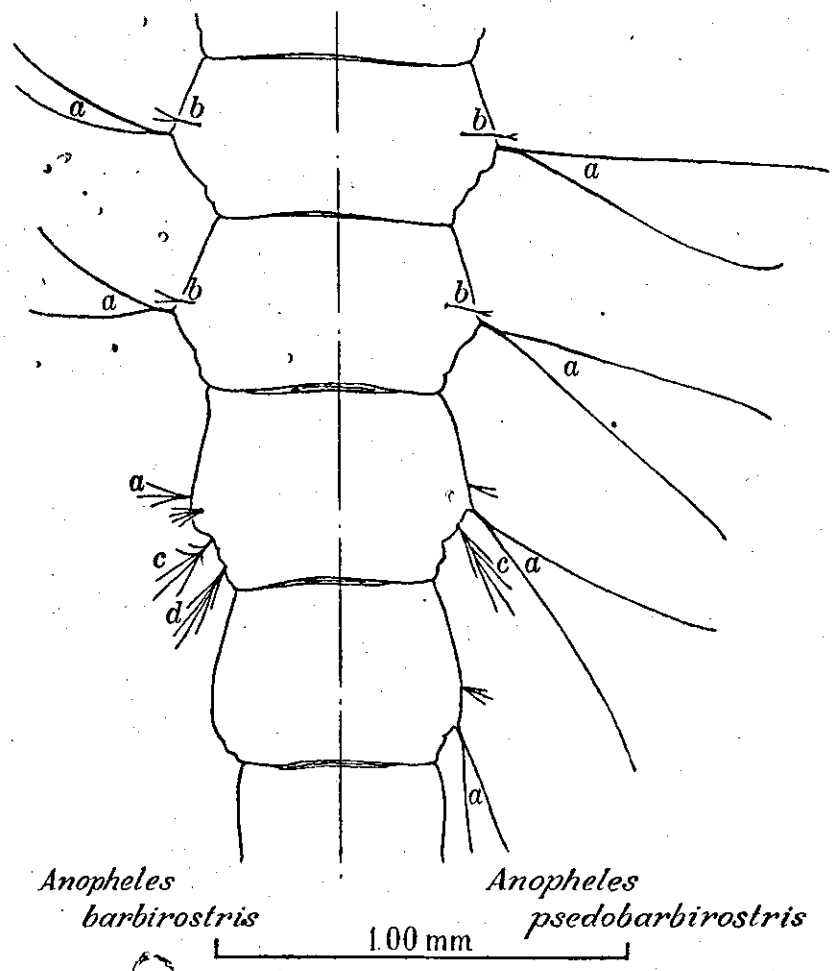

FIG. 8. *Anopheles barbirostris-pseudobarbirostris*, fourth, fifth, sixth, and seventh abdominal segments of larva; *a*, lateral hairs; *b*, antepalmate hairs; *c*, Martini's hair No. 9; *d*, Martini's hair No. 5.

Anopheles hyrcanus var. *sinensis*.—The larva of *A. hyrcanus* var. *sinensis* has—

(*a*) Inner anterior clypeal hairs simple, or one or the other or both forked, or coarsely branched as in fig. 1, *f*.

(*b*) Outer anterior clypeal hairs as shown in fig. 1, *b*.

(*c*) Postclypeal short, almost always branched, the branches originating from the base, except of course, when the branch is rebranched, and are well spread.

(*d*) Inner and outer occipital hairs averaging eight and six branches each, respectively.

(*e*) Length of the antennæ from 0.24 to 0.28 millimeter. The antennal hair arises at less than the basal half of the antennæ. Its branches average 10.5 each.

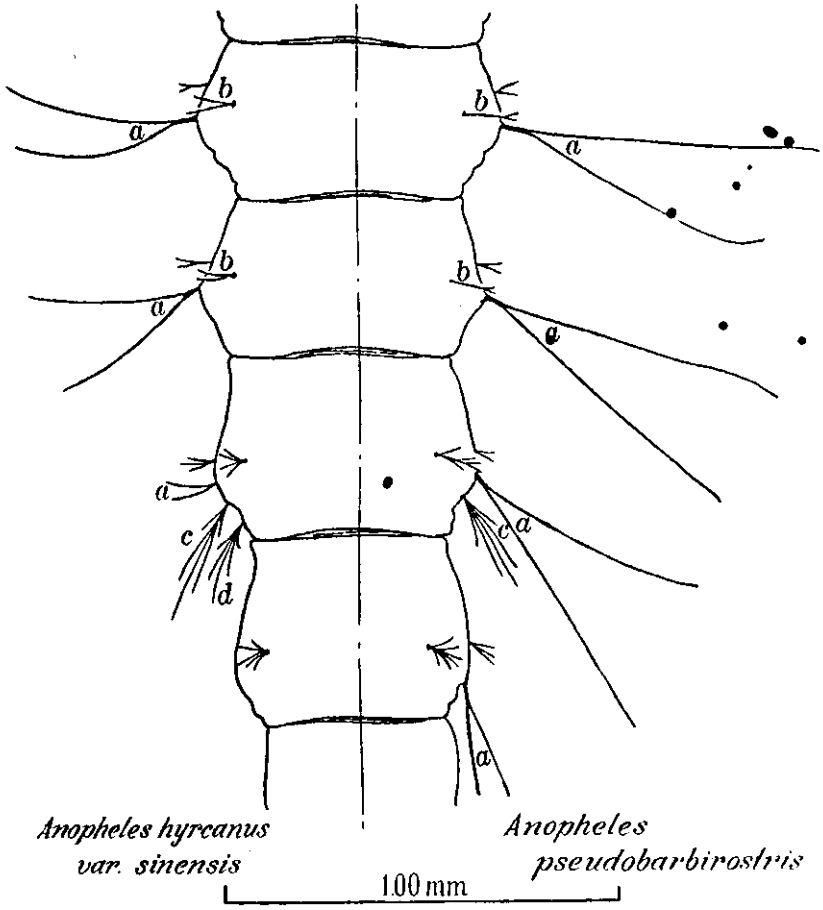

FIG. 4. *Anopheles sinensis-pseudobarbirostris*, showing fourth, fifth, sixth, and seventh abdominal segments; *a*, lateral hairs; *b*, antepalmate hairs; *c*, Martini's hair No. 9; *d*, Martini's hair No. 5.

(*f*) Inner anterior submedian thoracic short, simple or branched apically into usually only two or three. See Fig. 2 *a* and *j*. Generally the middle anterior submedian thoracic has fewer branches than that of either of the other species in this group, while the outer anterior submedian is occasionally bifid.

(*g*) Antepalmate of the fourth and fifth abdominal segments usually branched basally (see fig. 4, left side, *b*).

(*h*) Lateral hairs of the sixth abdominal segment short as of *barbirostris;* on the seventh absent.

(*i*) Hair No. 5 on the sixth abdominal segment present.

(*j*) No stigmal club (fig. 5, *a*).

In addition to the above some recognize a difference in shape and serrations of the leaflets of the abdominal palmate hairs, and

in the number of the long and short teeth of the lateral combs (refer to figs. 5, *e*, and 6, *a*). In this connection, it may be stated that the leaflets of the abdominal palmate of *barbirostris* show a more-marked variation than could be seen in any other species (see figs. 5, *g* and *h*).

Anopheles hyrcanus var. *nigerrimus*.—As stated above, the larva of *nigerrimus* differs so slightly, if at all, from *sinensis* that it would be extremely difficult if not impossible to tell which is which if they were together. They seem to breed separately, however, so that it would perhaps be better to differentiate them by means of the types of breeding places. For further details relative to the larva of this species, the reader is referred to Table 1.

THE ADULTS

Of the 167 *Anopheles barbirostris*, 110 *pseudobarbirostris*, 133 *hyrcanus* var. *sinensis*, and 168 *hyrcanus* var. *nigerrimus* larvæ isolated individually after examination, 108, 83, 96, and 111, respectively, reached the adult stage. They came out as follows:

	Males.	Females.
Anopheles barbirostris	43	65
Anopheles pseudobarbirostris	36	47
Anopheles hyrcanus var. *sinensis*	51	45
Anopheles hyrcanus var. *nigerrimus*	55	56

The rest of the larvæ died, some in the pupal stage, or else were discarded after staying in the isolation jars without apparent development for some days.

Detailed descriptions of these species in the adult forms can be found in various works,[42] so only the more important points need be recapitulated here, as follows:

Anopheles barbirostris van der Wulp.

(*a*) Shaggy palpi entirely black (Plate 1, fig. 3).

(*b*) Subcostal spot[43] of the wing variable in size and may as well as not involve the anterior, and sometimes also the posterior, portion of the first longitudinal vein.

[42] Anoph. Mosq. of Ceylon (1924), for *barbirostris*, *pseudobarbirostris*, and *hyrcanus*, pages 30–32; also pl. 15. Anoph. Mosq. of India ed. 2 (1911), for *barbirostris* and *sinensis;* also full figures of same. Handb. of Gnats or Mosq. ed. 2 (1902) 511, for *bancrofti;* page 308 for *barbirostris* and *sinensis*. Bull. Ent. Res. 12 (1922) 50, for *pseudobarbirostris;* pages 48–49 for *sinensis*. See also Stanton, Notes on Malayan Culicidae, page 69, for *barbirostris;* page 75 for *sinensis*.

[43] Root's pilotaxy of the wing is used here. See his studies on Brazilian mosquitoes, Am. Journ. Hyg. 6 (1926) 691 and pl. 1.

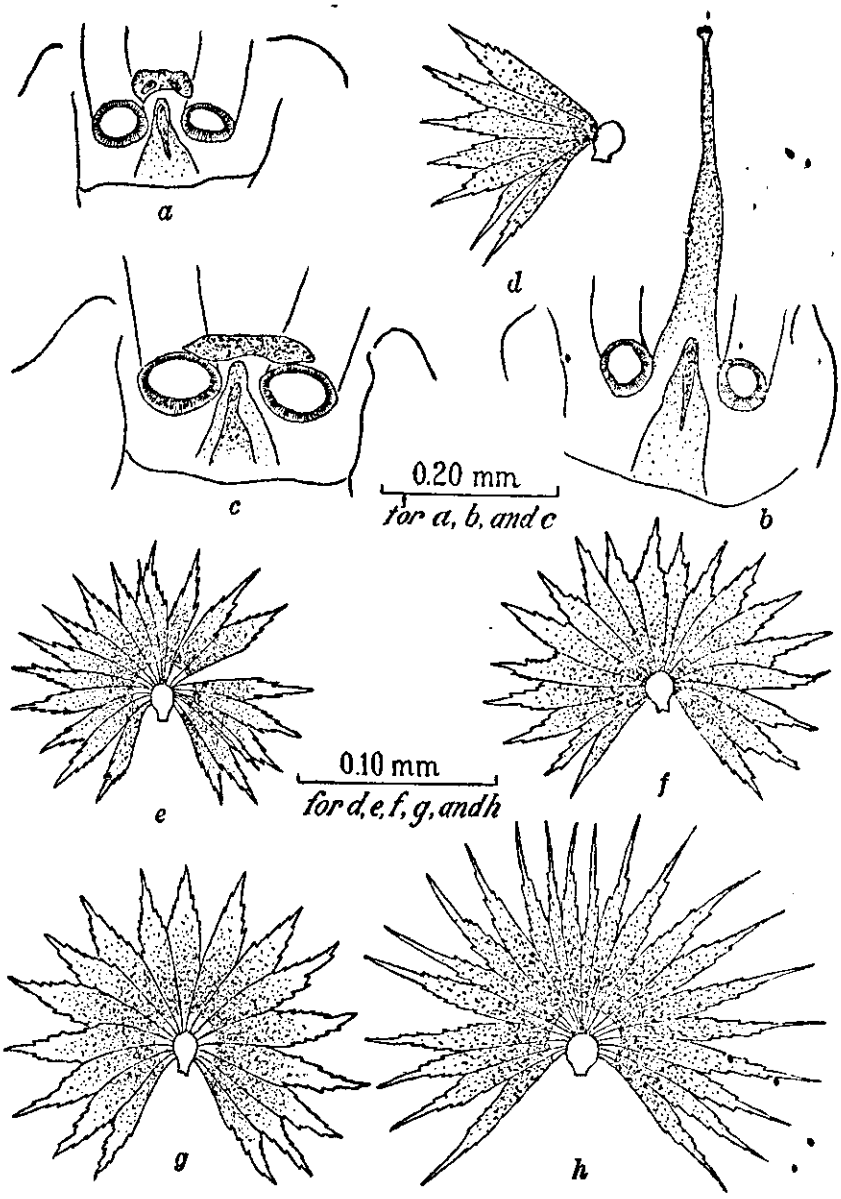

FIG. 5. Stigmal plate and palmate hair of the fourth abdominal segment in various species of *Anopheles*; *a*, *Anopheles hyrcanus* var. *sinensis* larva, stigmal plate; *b*, *Anopheles pseudobarbirostris* larva, stigmal plate, showing club; *c*, *Anopheles barbirostris* larva, stigmal plate; *d*, *Anopheles hyrcanus* var. *nigerrimus*, part of a palmate hair of the fourth abdominal segment; *e*, *Anopheles hyrcanus* var. *sinensis*, palmate hair of the fourth abdominal segment; *f*, *Anopheles pseudobarbirostris*, palmate hair of the fourth abdominal segment; *g* and *h*, *Anopheles barbirostris*, two types of palmate hairs of the fourth abdominal segment.

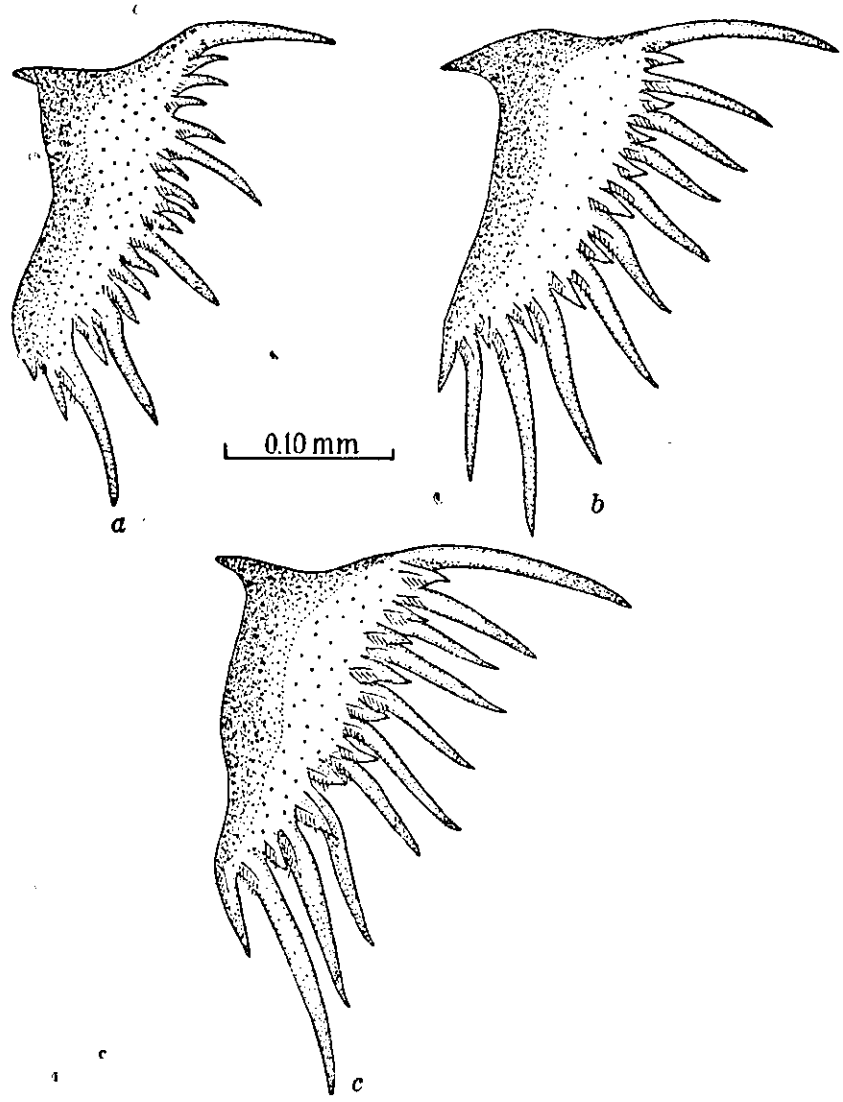

FIG. 6. Lateral comb in *Anopheles*; *a*, *Anopheles hyrcanus* var. *sinensis*; *b*, *Anopheles pseudobarbirostris*; *c*, *Anopheles barbirostris*.

(*c*) There is usually one (at times none) basal costal spot.

(*d*) The apical spot has usually a black interruption at its middle, which may at times be wanting, or else joined with the black rim toward the apex.

(*e*) The next spot is opposite the third longitudinal but may be as wide as to involve also the area opposite 4.1.

(*f*) The fringe spot opposite 5.2 is variable in size and may sometimes be entirely wanting.

TABLE 1.—*Comparative table of larval hairs in two species and two varieties of Anopheles.*

Character.	*Anopheles barbirostris.*		*Anopheles pseudobarbirostris.*		*Anopheles hyrcanus* var. *sinensis.*		*Anopheles hyrcanus* var. *nigerrimus.*	
		Per cent.		*Per cent.*		*Per cent.*		*Per cent.*
Inner anterior clypeal hairs.								
Simple	116	74	0	0	45	37	154	92
One or both branched	40	26	110	100	75	63	12	8
Outer anterior clypeal hairs.								
Number of branches	20–40		47–63		31–42		28–76	
Average number of branches	30		54		37		45	
Postclypeal hairs.								
Simple	5	8	77	86	1	2	2–8	
One or both branched	52	92	12	14	55	98	120	100
Inner occipital hairs.								
Number of branches	5–16		6–13		6–12		3–10	
Average number of branches	10		10.4		8.3		6	
Outer occipital hairs.								
Number of branches	6–15		2–11		3–11		2–8	
Average number of branches	9.6		6.9		6.0		5.0	
Antenna.								
Range of length.....mm	0.25–0.35		[b]0.30–0.35		0.24–0.28		[a]0.30–0.35	
Average length.....mm	0.30		0.32		0.25		0.32	
Antennal hair.								
Number of branches	4–24		11–24		6–15		5–8	
Average number of branches	8		16.5		10.5		6.0	
Average position of antennal hair from the base of the antenna	½		½ or <		½ or <		< ½	
Inner anterior submedian thoracic hair.								
Number of branches	4–15		1–6		28	21	81	48
Average number of branches	8		3.0		104	79	86	52
Middle anterior submedian thoracic hair.								
Number of branches	9–19		8–17		6–13		9–19	
Average number of branches	14		12.8		10.0		14.0	
Lateral hairs of sixth abdominal segment	Short in all.		Long in all.		Short in all.		Short in all.	
Lateral hairs of seventh abdominal segment	Absent in all.		Present in all.		Absent in all.		Absent in all.	
Hair 5 of sixth abdominal segment	Present in all.		Absent in all.		Present in all.		Present in all.	
Stigmal club	Absent in all.		Present in all.		Absent in all.		Absent in all.	

[a] In one specimen the antenna measured 0.28 millimeter only.

[b] In one specimen the antenna measured 0.29 millimeter only.

(*g*) Scattered black scales very often present basal to the second black lengths from the apex of the sixth longitudinal vein (see Plate 2, figs. 1, 2, and 3).

(*h*) Its legs, described as "sooty" by Giles, "inconspicuously spotted" by Carter,[44] and "dark brown to black" by James and Liston,[45] appear to me to have very widely scattered brownish or dull whitish narrow scales which are by no means as conspicuous or pronounced as those in *pseudobarbirostris* (see Plate 1, figs. 9 and 10).

(*i*) Mesepimeral white scales present. Some white scales may also be present on the ventral side of the abdomen but the ventral segmental white scales as shown in Rodenwaldt's chart[46] is not a constant characteristic. This particular point is usual in *pseudobarbirostris*. The black ventral tuft of the female abdomen has white scales on its cephalic side (see fig. 7, *h*).

(*j*) Male mesosome long with long serrated leaflets (see fig. 7, *e*).

Anopheles pseudobarbirostris.

(*a*) Unbanded, shaggy palpi (see Plate 1, fig. 4).

(*b*) Subcostal spot similar to and as variable as that of *barbirostris*.

(*c*) There may be one or two basal costal spots.

(*d*) Similarly, the apical spot may or may not have the black interruption at the middle.

(*e*) The next spot is opposite 4.1.

(*f*) The fringe spot opposite 5.2 is variable in size and may also be absent.

(*g*) Scattered black scales basal to second black length from the apex of the sixth longitudinal present (see, Plate 2, fig. 4, and Plate 3, fig. 1).

(*h*) The legs are described as "flecked with scattered white scales" by Christophers[47] and "well sprinkled with white scales" by Ludlow.[48] These white scales are easily detected under the microscope particularly on the ventral aspect of the fore femur where the white scales predominate over the black ones (see Plate 1, figs. 11, 12, and 13).

(*i*) Mesepimeral white scales absent, but clumps of them elsewhere on the pleura and coxæ show conspicuously. There are also white scales cephalad and caudad to the female black ventral tuft (refer to fig. 7, *f*), and a symmetrically arranged group of white ones, three or more in a group in females, less in males, on every segment, except the first.

(*j*) Mesosome of the male long with long unserrated leaflets (fig. 7, *c*).

[44] Anoph. Mosq. of Ceylon, pt. 1 (1924) 31–32.

[45] Anoph. Mosq. of India, ed 2 (1911) 15.

[46] De Anoph. van Nether. Oost-Indie.

[47] Prov. List and Ref. Cat. Anoph. (1924) 32.

[48] U. S. Army Bull. Office of the Surg. Gen. No. 4 (November, 1913) 53.

Anopheles hyrcanus var. *sinensis*.

(*a*) Palpi white banded. These bands are so variable in breadth that a number of types could be built from them if what seems to be indicated by Christophers[49] is followed. He recognizes a difference in breadth of the third white band from the apex in relation to the apical and subapical bands between *hyrcanus* and *sinensis*. Ours have theirs usually narrower than the apical or subapical but many be wider. The queerest of them all, however, is when the apical and subapical join together to form only one (Plate 1, figs. 1 and 2; see Table 2).

(*b*) The subcostal spot is almost always wide and involves the anterior as well as the posterior portion of the first longitudinal.

(*c*) Basal costal spot absent.

(*d*) The apical spot is continuous without any black interruption at the middle.

(*e*) The next spot extends sometimes from opposite 2.1 to midway between 3 and 4.1.

(*f*) Fringe spot opposite 5.2 rarely present.

(*g*) Usually there are no scattered black scales basal to the second black length from the apex of the sixth longitudinal vein, and the two black lengths of this vein may join together to form a long one (Plate 3, fig. 2).

(*h*) Legs without scattered white scales (Plate 1, figs. 7 and 8).

(*i*) No mesepimeral white scales and very scanty if at all elsewhere on the pleura or coxæ.

(*j*) Mesosome short with short leaflets, both sides of which are unevenly serrated (fig. 7, *a* and *d*).

Anopheles hyrcanus var. *nigerrimus* differs so markedly from var. *sinensis* in the very wide bandings of the fore and hind tarsi that it can be determined even with the unaided eyes. Microscopical measurements show that its palpal bands are somewhat wider, particularly the apical, than those of *sinensis*. The next bands, however, are usually so indefinite and incomplete (the third may be entirely absent) that they may as well not be called bands at all. Moreover, under certain lights even the black scales appear silvery, thus making the definition of the bands more vague. Like those of *sinensis* the apical and subapical bands may be fused to form one. The wing appears darker than that of *sinensis*, due to the smallness of the subcostal and apical spots, and the absence of the pale interruption involving both the subcosta at about one-third from the base, and the point adjacent to it of the first longitudinal. There are also

[49] Prov. List and Ref. Cat. Anoph. (1924) 32.

no other yellow interruptions elsewhere in the first longitudinal except near its apex, while the second and fourth have continuous black toward the base. The fringe spot at the tip of the wing extends from opposite the first longitudinal to almost 4.1 in some instances, while the fringe spot opposite 5.2 has not been seen in any of our specimens (compare Plate 3, figs. 2, 3, and 4; see Table 3).

The first three tarsi of the fore legs of *nigerrimus* have very wide apical white bands. Exception of the first tarsi has to be made, sometimes, as its minimum is even lower than that of *sinensis* (0.03 to 0.05 millimeter) although it has a maximum measurement of 0.28 to 0.16 millimeter of *sinensis*. The second has the same exception to the rule so that only the third can be used with certainty (refer to Table 2, and Plate 1, figs. 5 and 6). The second, third, and fourth hind tarsi show very definite differences from those of *sinensis* as can be seen by referring to Table 4.

TABLE 2.—*Comparative table of palpal bands in two varieties of Anopheles hyrcanus.*

Counting from the tip.	Band.					
	First.		Second.		Third.	
	Anopheles hyrcanus var. *sinensis.*	*Anopheles hyrcanus* var. *nigerrimus.*	*Anopheles hyrcanus* var. *sinensis.*	*Anopheles hyrcanus* var. *nigerrimus.*	*Anopheles hyrcanus* var. *sinensis.*	*Anopheles hyrcanus* var. *nigerrimus.*
None	0	0	0	0	0	2
Mere suggestion	0	0	0	0	0	20
0.02 mm occurs	4	0	0	0	0	0
0.05 mm occurs	23	2	2	19	7	24
0.08 mm occurs	10	8	27	26	29	10
0.10 mm occurs	1	28	8	5	1	1
0.12 mm occurs	0	6	0	0	0	0
0.15 mm occurs	0	6	0	0	0	0
Average width—mm	0.05	0.10	0.08	0.07	0.07	(a)

Band.	Times.	
First = second = third	2	0
Second = third	12	15
Third less than second	22	31
Third wider than second	4	1
First and second fused together	2	7

[a] Almost nil.

The thecal leaflets show very few serrations, which are confined only to the outer border of the largest, and sometimes also of the next largest, leaflets (fig. 7, *b*).

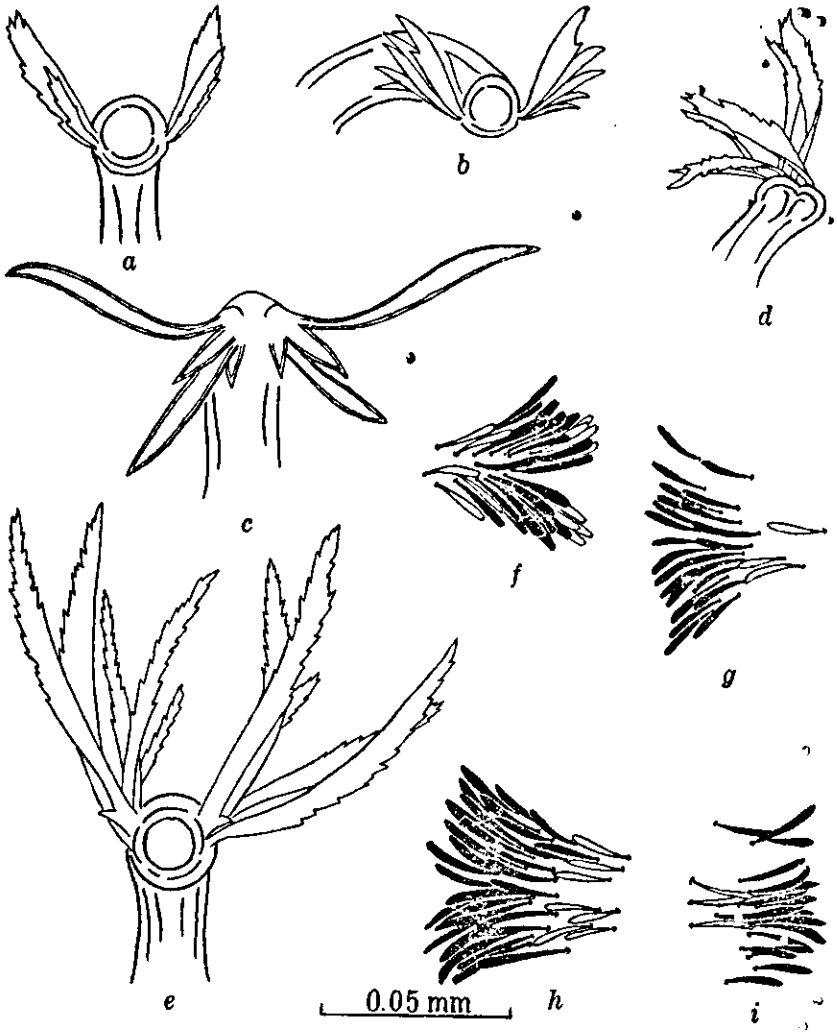

FIG. 7. Mesosome and scale tuft in various species of *Anopheles*; *a*, *Anopheles hyrcanus* var. *sinensis*, distal part of mesosome and its leaflets; *b*, *Anopheles hyrcanus* var. *nigerrimus*, distal portion of mesosome and its leaflets; *c*, *Anopheles pseudobarbirostris*, distal portion of mesosome and its leaflets; *d*, *Anopheles hyrcanus* var. *sinensis*, mesosome and leaflets, isolated and pressed under a cover glass; *e*, *Anopheles barbirostris*, distal portion and leaflets of mesosome; *f*, *Anopheles pseudobarbirostris*, female, ventral scale tuft of the abdomen; *g*, *Anopheles hyrcanus* var. *nigerrimus*, female, ventral scale tuft of the abdomen; *h*, *Anopheles barbirostris*, female, ventral scale tuft of the abdomen; *i*, *Anopheles hyrcanus* var. *sinensis*, female, ventral scale tuft of the abdomen.

TABLE 3.—*Comparative table of wing spots in two species and two varieties of Anopheles.*

Character.	*Anopheles barbirostris.*		*Anopheles pseudobarbirostris.*		*Anopheles hyrcanus* var. *sinensis.*		*Anopheles hyrcanus* var. *nigerrimus.*	
		Per ct.		*Per ct.*		*Per ct.*		*Per ct.*
Basal costal spot.								
None	21	22.5	13	19	75	100	116	100
One	72	77.5	40	60	0	.....	0	.....
Two	0	0	14	21	0	.....	0	.....
Subcostal spot.								
Minimum length.....mm.	0.07	.....	0.07	.....	0.10	.....	(a)	.....
Maximum length.....mm.	0.18	.....	0.20	.....	0.20	.....	0.20	.....
Average length.....mm.	0.12	.....	0.12	.....	0.14	.....	0.12	.....
Commonest.....mm.	0.15	.....	0.10	.....	0.15	.....	0.10	.....
Number measured	79	.....	67	.....	73	.....	115	.....
Apical spot.								
Black at middle	69	80	61	95	0	.....	0	.....
Without black	19	20	3	(b)5	.....	100	.....	100
Total examined	88	.....	64	.....	72	.....	116	.....
Fringe spot at wing tip.								
Opposite 3 only	45	50	0	.....	0	.....	0	.....
Opposite 4.1 only	14	16	66	.....	0	.....	0	.....
Opposite 3 to 4.1	31	34	(c)1	.....	0	.....	0	.....
Opposite 1 to 3	.....	.....	.....	.....	0	.....	61	54
Opposite 1 to 4.1	.....	.....	.....	.....	0	.....	3	2.5
Opposite 2.1 to 3	.....	.....	.....	.....	72	100	47	42.0
Opposite 2.1 to 4.1	.....	.....	.....	.....	0	.....	2	1.5
Fringe spot opposite 5.2.								
Present	87	93	64	96	2	3	0	.....
Absent	6	7	3	4	73	97	.....	100
Total examined	93	.....	67	.....	75	.....	116	.....

[a] Mere suggestion. [b] Very faint. [c] Absent.

SUMMARY

For some years the Philippines has been credited with a number of species belonging to the so-called "Myzorhynchus" group (now "Anopheles") of anopheline mosquitoes. The earliest accounts were based on adults caught wild and sent to foreign countries for determination. The present study is an attempt at a systematic treatment of these insects from the larval to the adult stages. As a result, it has been shown that the Philippine species do not exactly tally with the descriptions given for the same species in other countries. The main points of differentiation in both the larval and adult forms of the species studied are here given. The lateral hairs, and hairs Nos. 5 and 9 (Martini's) of the sixth segment, and the stigmal club are used in addition to those commonly employed in the determination of larvæ. A discussion of the available literature as a basis of comparison with the Philippine species is also included.

TABLE 4.—*Comparative table of tarsal rings in two species and two varieties of Anopheles.*

Character.	*Anopheles barbirostris.*	*Anopheles pseudobarbirostris.*	*Anopheles hyrcanus* var. *sinensis.*	*Anopheles hyrcanus* var. *nigerrimus.*
Fore tarsi; first ring.				
Minimum.....mm.	0.08	0.05	0.05	0.03
Maximum.....mm.	0.14	0.10	0.16	0.28
Average.....mm.	0.10	0.07	0.10	0.11
Commonest.....mm.	0.10	0.07	0.10	0.08
Number measured.....	62	51	71	114
Fore tarsi; second ring.				
Minimum.....mm.	0.03	0.03	0.07	0.08
Maximum.....mm.	0.10	0.10	0.17	0.47
Average.....mm.	0.08	0.05	0.12	0.24
Commonest.....mm.	0.08	0.05	0.12	0.20
Number measured.....	62	51	71	115
Fore tarsi; third ring.				
Minimum.....mm.				0.10
Maximum.....mm.				0.35
Average.....mm.				0.18
Commonest.....mm.				0.20
Number measured.....				115
Hind tarsi; first ring.				
Minimum.....mm.	0.07	0.05	0.02	
Maximum.....mm.	0.10	0.10	0.10	
Average.....mm.	0.09	0.077	0.067	(a)
Commonest.....mm.	0.10	0.10	0.07	
Number measured.....	43	56	71	
Hind tarsi; second ring.				
Minimum.....mm.	0.07	0.05	0.04	0.08
Maximum.....mm.	0.10	0.10	0.12	0.27
Average.....mm.	0.08	0.07	0.087	0.16
Commonest.....mm.	0.08	0.07	0.10	0.18
Number measured.....	43	56	71	115
Hind tarsi; third ring.				
Minimum.....mm.			0.05	0.18
Maximum.....mm.			0.12	0.35
Average.....mm.			0.09	0.26
Commonest.....mm.			0.10	0.25
Number measured.....			71	115
Hind tarsi; fourth basal ring.				
Minimum.....mm.			0.00	0.05
Maximum.....mm.			0.02	0.18
Average.....mm.				0.13
Commonest.....mm.			0.00	0.10
Number measured.....			61	115
Hind tarsi; fourth apical ring.				
Minimum.....mm.			0.03	0.10
Maximum.....mm.			0.10	0.28
Average.....mm.			0.07	0.17
Commonest.....mm.			0.07	0.15
Number measured.....			71	115

[a] Insignificant.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Anopheles sinensis*, female palpi, dorsal view.
2. *Anopheles sinensis*, female palpi, dorsal view (uncommon).
3. *Anopheles barbirostris*, female palpi, dorsal view.
4. *Anopheles pseudobarbirostris*, female palpi, dorsal view.
5. *Anopheles hyrcanus* var. *nigerrimus*, fore tarsi.
6. *Anopheles hyrcanus* var. *nigerrimus*, hind tarsi.
7. *Anopheles hyrcanus* var. *sinensis*, fore tarsi.
8. *Anopheles hyrcanus* var. *sinensis*, hind tarsi.
9. *Anopheles barbirostris*, fore tarsi.
10. *Anopheles barbirostris*, hind tarsi.
11. *Anopheles pseudobarbirostris*, fore tarsi.
12. *Anopheles pseudobarbirostris*, hind tarsi.
13. *Anopheles pseudobarbirostris*, portion of hind femur, highly magnified, showing the white and black scales.

PLATE 2

FIG. 1. *Anopheles barbirostris*, female wing, showing a very faint black interruption at the middle of the apical spot.
2. *Anopheles barbirostris*, female wing, showing the absence of the fringe spot opposite the posterior fork of the fifth longitudinal vein.
3. *Anopheles barbirostris*, female wing, showing smaller spots. (Compare with fig. 2.)
4. *Anopheles pseudobarbirostris*, female wing.

PLATE 3

FIG. 1. *Anopheles pseudobarbirostris*, female wing.
2. *Anopheles hyrcanus* var. *sinensis*, female wing, showing the yellow interruption at about the middle of the subcosta, involving also the first longitudinal vein. Note also the size of the subcostal spot compared with those of the following two figures.
3. *Anopheles hyrcanus* var. *nigerrimus*, female wing, showing the smallness of the subcostal and apical spots; also the absence of the yellow spot involving the subcosta and first longitudinal. Note the predominance of black scales on the second and fourth longitudinal veins in contrast with those of *A. sinensis*.
4. *Anopheles hyrcanus* var. *nigerrimus*, female wing, showing only one continuous black length on the sixth longitudinal. This peculiarity also occurs in *A. sinensis*.

TEXT FIGURES

FIG. 1. Anterior clypeal hairs in *Anopheles; a, Anopheles barbirostris* van der Wulp, outer anterior clypeal hair; *b, Anopheles hyrcanus* var. *sinensis* Wiedeman, outer anterior clypeal hair; *c, Anopheles pseudobarbirostris* Ludlow, outer anterior clypeal hair; *d, Anopheles barbirostris* van der Wulp, inner anterior clypeal hairs; *e, Anopheles barbirostris* van der Wulp, inner anterior clypeal hairs (unusual); *f, Anopheles hyrcanus* var. *sinensis*, inner anterior clypeal hairs (uncommon); *g, Anopheles pseudobarbirostris* Ludlow, inner anterior clypeal hairs.

2. Inner anterior submedian thoracic hairs in *Anopheles; a*, and *j, Anopheles hyrcanus* var. *sinensis* Wiedeman; *b*, and *h, Anopheles barbirostris* van der Wulp; *c, i*, and *k, Anopheles pseudobarbirostris* Ludlow; *d, e, f*, and *g, Anopheles hyrcanus* var. *nigerrimus* Giles.

3. *Anopheles barbirostris-pseudobarbirostris*, fourth, fifth, sixth, and seventh abdominal segments of larva; *a*, lateral hairs; *b*, antepalmate hairs; *c*, Martini's hair No. 9; *d*, Martini's hair No. 5.

4. *Anopheles sinensis-pseudobarbirostris*, showing fourth, fifth, sixth, and seventh abdominal segments; *a*, lateral hairs; *b*, antepalmate hairs; *c*, Martini's hair No. 9; *d*, Martini's hair No. 5.

5. Stigmal plate and palmate hair of the fourth abdominal segment in various species of *Anopheles; a, Anopheles hyrcanus* var. *sinensis* larva, stigmal plate; *b, Anopheles pseudobarbirostris* larva, stigmal plate, showing club; *c, Anopheles barbirostris* larva, stigmal plate; *d, Anopheles hyrcanus* var. *nigerrimus*, part of a palmate hair of the fourth abdominal segment; *e, Anopheles hyrcanus* var. *sinensis*, palmate hair of the fourth abdominal segment; *f, Anopheles pseudobarbirostris*, palmate hair of the fourth abdominal segment; *g* and *h, Anopheles barbirostris*, two types of palmate hairs of the fourth abdominal segment.

6. Lateral comb in *Anopheles; a, Anopheles hyrcanus* var. *sinensis; b, Anopheles pseudobarbirostris; c, Anopheles barbirostris.*

7. Mesosome and scale tuft in various species of *Anopheles; a, Anopheles hyrcanus* var. *sinensis*, distal part of mesosome and its leaflets; *b, Anopheles hyrcanus* var. *nigerrimus*, distal portion of mesosome and its leaflets; *c, Anopheles pseudobarbirostris*, distal portion of mesosome and its leaflets; *d, Anopheles hyrcanus* var. *sinensis*, mesosome and leaflets, isolated and pressed under a cover glass; *e, Anopheles barbirostris*, distal portion and leaflets of mesosome; *f, Anopheles pseudobarbirostris*, female, ventral scale tuft of the abdomen; *g, Anopheles hyrcanus* var. *nigerrimus*, female, ventral scale tuft of the abdomen; *h, Anopheles barbirostris*, female, ventral scale tuft of the abdomen; *i, Anopheles hyrcanus* var. *sinensis*, female, ventral scale tuft of the abdomen.

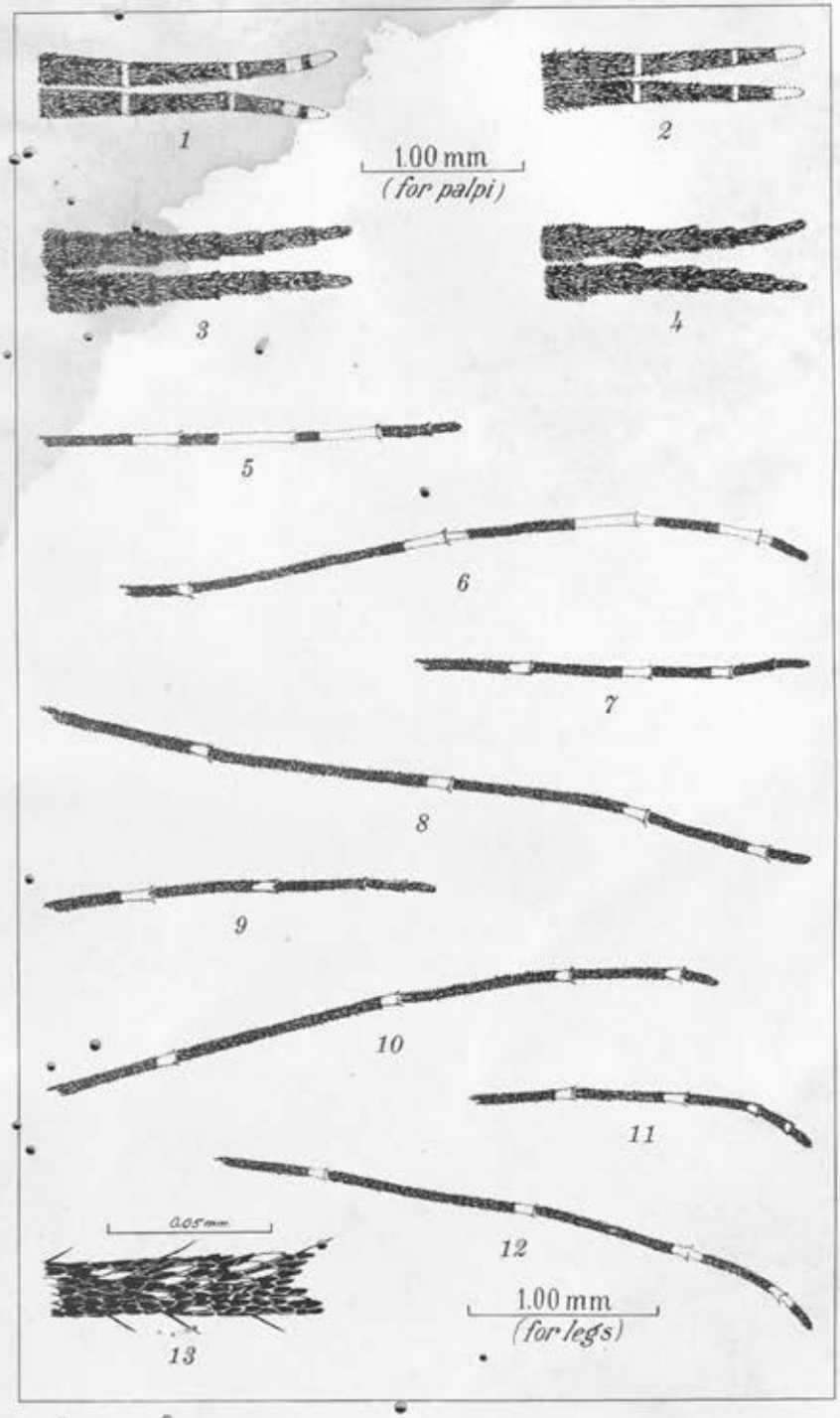

PLATE 1.

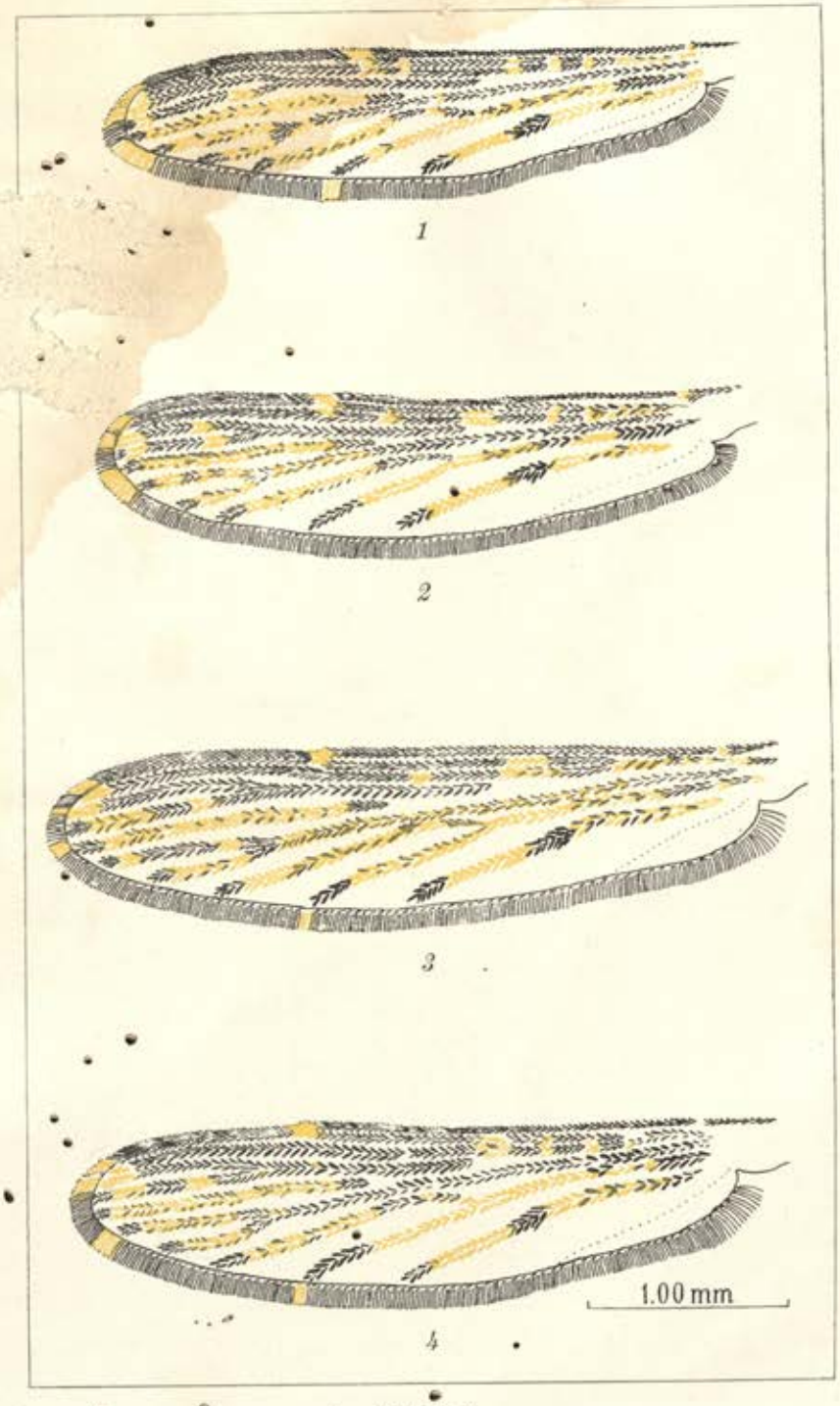

PLATE 2.

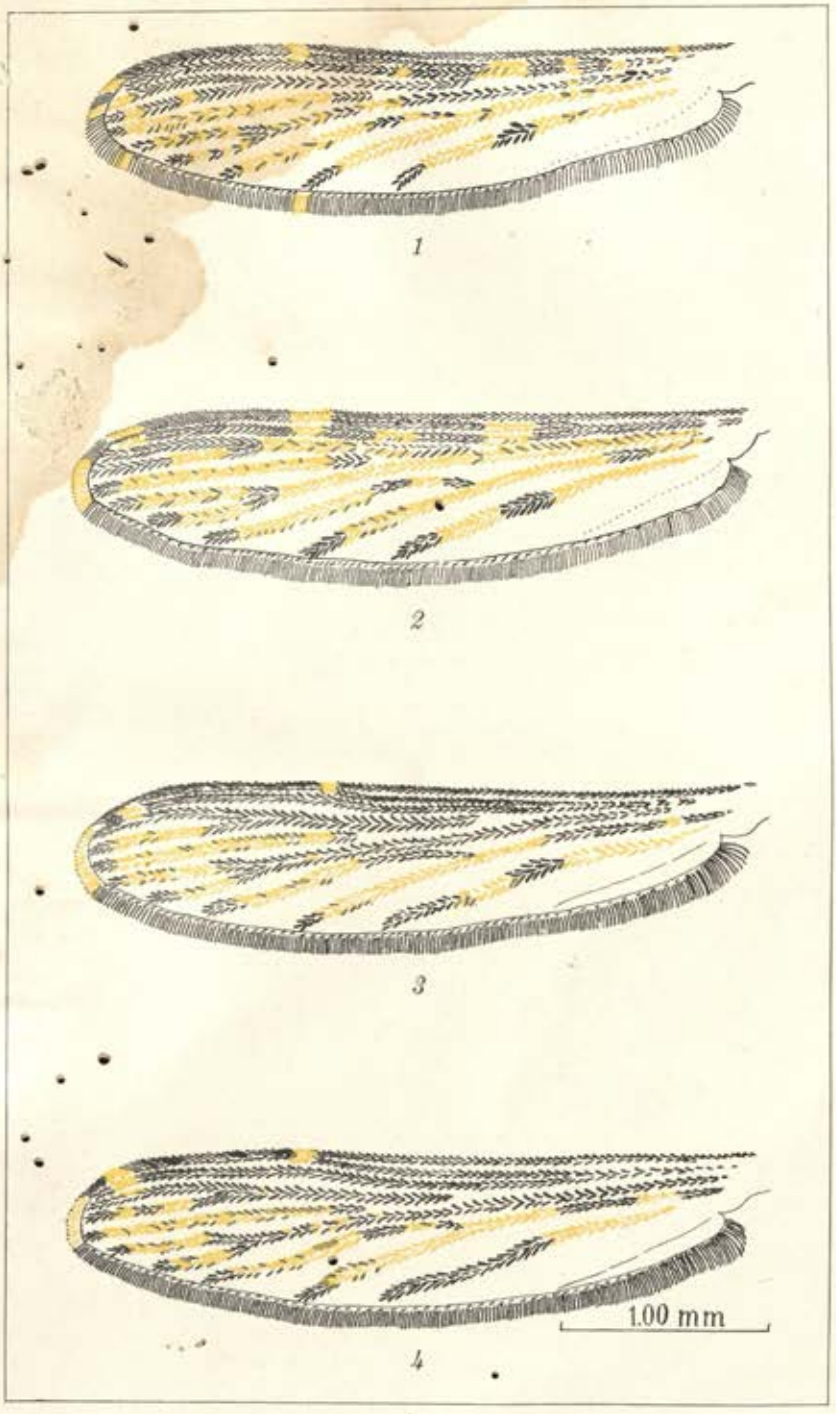

PLATE 3

REPORT OF THE LEONARD WOOD MEMORIAL CONFERENCE ON LEPROSY

HELD IN MANILA, PHILIPPINE ISLANDS, JANUARY 9 TO 23, 1931

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Suspected; clinical; incipient; infectious; burned-out; arrested with deformity; leper; case of leprosy.
2. Designation of lesions.
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3. The microörganism.
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Primary classification; proposed classification of types of leprosy; main types; subtypes.
5. Administrative classification of cases.
Open; closed.
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THE INTERNATIONAL LEPROSY ASSOCIATION.
RESOLUTIONS.

FOREWORD

It has long been evident to those engaged in the study and control of leprosy, that the existing terminology and classification of the subject permitted of widely divergent interpretations. This defect had become a handicap of such degree in correlating the views and results of different leprologists, that an opportunity for discussion and attempted correction of some of the difficulties seemed to be an imperative requirement for progress.

During the past year both the Leonard Wood Memorial for the Eradication of Leprosy and the Leprosy Commission of the League of Nations took cognizance of the situation, and became interested in holding a round-table conference, in the Far East, and the trustees of the Memorial subsequently made a financial allotment to effect this purpose in so far as it was practicable. It was decided that the Conference should take place in Manila immediately after the meeting of the Leprosy Commission, which was held in Bangkok in December, 1930.

The number of leprologists invited to the Conference was necessarily limited since it was intended that the proceedings should be of the nature of informal discussions. It seemed especially desirable that those individuals who are members of the Leprosy Commission of the League of Nations, or their representatives, should attend because of their previous studies of the subject, and of their broad knowledge of the conditions prevailing in the widely scattered areas which are affected. Invitations were extended to a number of others who were located in the Far East, and whose experience was known to include unique aspects.

The Conference convened at Manila January 9, 1931, and was in session until January 23, 1931. Those who attended are as follows:

Dr. ET. BURNET, secretary, Leprosy Commission, League of Nations.
Dr. R. G. COCHRANE, secretary, British Empire Leprosy Relief Association.
Dr. H. I. COLE, chief chemist, Culion Leper Colony.

Dr. J. FAJARDO, director of health, Philippine Health Service.
Maj.-Gen. J. D. GRAHAM, I. M. S., public health commissioner, Government of India.
Dr. G. GUSHUE-TAYLOR, superintendent, Mackay Memorial Hospital, Taihoku, Formosa.
Dr. V. G. HEISER, director for the Far East, Rockefeller Foundation.
Dr. LEE S. HUIZENGA, superintendent, Mission Hospital, Jukao, Ku, China.
Dr. A. N. KINGSBURY, director, Research Institute, Kuala Lumpur, Federated Malay States.
Capt. P. H. J. LAMPE, director of health, Dutch Guiana.
Dr. C. B. LARA, chief physician, Culion Leper Colony.
Dr. J. LOWE, medical superintendent, Dichpalli Leprosy Hospital, India.
Dr. J. L. MAXWELL, Henry Lester Institute of Medical Research, Shanghai.
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Dr. E. E. NEFF, superintendent, Mogokai Central Leper Hospital, Fiji.
Prof. Dr. B. NOCHT, president, Leprosy Commission, League of Nations.
Dr. M. OTA, Tohoku Imperial University, Japan.
Dr. J. N. RODRIGUEZ, supervisor of leprosy-treatment stations, Philippine Health Service.
Dr. J. C. TULL, government pathologist, Singapore.
Dr. H. W. WADE, chief pathologist, Culion Leper Colony; and medical director, Leonard Wood Memorial.
Dr. N. E. WAYSON, director, United States Leprosy Investigation Station, Hawaii.
Drs. LEROY-DESBARRES and H. JOYEOUX, of French Indo-China, also participated in the first sessions.

The Conference was organized at the first meeting, and the agenda for consideration was agreed upon promptly thereafter. The subject matter was prepared for the most part in committee, presented to the plenary sessions, and final decisions reached in these. January 14, the members embarked on a journey of inspection of regional treatment stations and leprosaria at Cebu, Zamboanga, and Iloilo, and of the Culion Leper Colony. The sessions were continued with but brief intermissions throughout the tour, both on the steamer and at ports visited.

The discussions were frank and detailed, and were in most instances extended to a point of reconciliation of viewpoints and common agreement. The following report is that decided upon by the Conference in plenary sessions.

H. W. WADE, *Chairman of Conference.*
G. GUSHUE-TAYLOR, *Secretary.*

DISCUSSIONS AND CONCLUSIONS

I. THE INTERNATIONAL VIEWPOINT

An important cause of misunderstanding among leprosy workers is their insufficient appreciation of fundamental differences in conditions and practices existing in different regions. Leprosy has a wide range of manifestations and the predominating features, such as the frequency of one or another type, may vary widely in different regions. Local conditions of various kinds must determine the nature of antileprosy activities. The results of work may be influenced by such factors as the type of case, the degree of advancement of the disease, and the conditions under which the patient is observed. It is important that leprologists bear such factors in mind in order that they may precisely evaluate their own findings, particularly with regard to the work of others, and avoid the formulation of unduly broad conclusions.

Study tours.—It is deemed highly advisable that any country or institution undertaking serious work in leprosy should send some of its leading workers to one or more of the main centers of leprosy activities, in order to study the local conditions and the methods in use. The value of this lies not only in the knowledge acquired that can be applied directly to the visitor's own work, but also in the broadening of his outlook on the leprosy problem as a whole.

Transfer of workers.—It not infrequently happens that the results obtained by a worker or group in one country are not confirmed by those working in other countries. Whether this is due to peculiarities of conditions prevailing, or to the personal equation, or to other factors is usually not apparent. Progress toward the clarification of questions of regional differences could undoubtedly be accelerated were it possible for persons who have carried out studies in one region to be transferred to another in order to continue or repeat such studies there or to undertake correlative investigations. It is deemed desirable to bring the possibilities of such a plan to the notice of institutions and organizations concerned with the study of leprosy.

Leprosy digest, or annuaire.—It is unquestionably difficult for isolated workers to gain from the available literature an adequate understanding of conditions prevailing in other regions. There is need of a reference work of the nature of a comprehensive leprosy survey, or annuaire, which would afford a reasonably accurate summary of what is known of the leprosy

situation in all parts of the world. It should include information regarding the extent and distribution of the disease in the various countries or regions, the predominating types, other factors that affect leprosy work, and the laws and regulations obtaining; it should also include statements of activities, lists and brief descriptions of institutions, and perhaps data concerning active leprologists. The existing information of this nature is widely scattered and incomplete. It should be collected, summarized, amplified where necessary, and brought up-to-date. The preparation and periodical revision of such a survey would be a laborious and somewhat expensive task, hardly possible except through the agency of an organization such as the Leprosy Commission of the League of Nations or an association of leprologists. The matter should, however, be given serious consideration.

II. UNIFORMITY OF METHODS AND TERMS

Differences in terminology, in classification and subclassification of cases, in methods of examination and treatment, and in other features are felt to be a serious handicap to leprosy work in general. There is little possibility of arriving at uniformity of practice in certain features, notably the methods used in the general antileprosy campaign, but in other matters it should be feasible to arrive at some degree of standardization.

1. DESIGNATIONS OF CASES OF LEPROSY

It is confusing, when there is need of precision, if the term "case of leprosy" is applied indiscriminately to all types, from those that are active but with slight involvement, to those with marked mutilations but in which all evidence of activity has long since disappeared and only the permanent sequelæ remain. Reports should be precise, indicating the types of cases, and the subtypes based on degree of advancement (see page 457); the proportions of each should also be stated. Unless this is done it is impossible to compare the results obtained in different institutions. There should, also, be uniformity in the use of other terms employed in designating cases of leprosy.

The term "suspected" case applies to a patient who presents clinical signs that are suggestive of leprosy but not sufficient for a definite diagnosis.

The term "clinical" case is sometimes applied to distinguish one that is diagnosed on clinical grounds, the bacteriological findings being negative.

The term "incipient" case is sometimes applied to an early or slight case in which the bacteriological findings are negative; this has been used where the "cutaneous" type greatly predominates and patients with bacteriologically positive findings are isolated.

Since the terms "clinical" and "incipient" are to a certain extent indefinite, it is preferable that whenever possible more specific terms be used (see page 455).

The term "infectious" case is much used, chiefly in connection with administrative measures. The use of this term is not recommended; attention is called to Administrative Classification of Cases, page 458.

The term "burned-out" case is often applied to arrested cases that show mutilations, contractures, etc. It is recommended that the use of this term be discontinued and that "arrested with deformity" be employed.

The term "leper" is felt to carry with it a definite social stigma. It is recommended that the use of this term be discontinued and that "case of leprosy" be employed.

2. DESIGNATION OF LESIONS

Leprosy may produce pathological changes in many tissues of the body. The nerves, skin and mucous membranes, eyes, bones, lymph glands, testes, and other organs may be affected. For present purposes, attention will be confined to those changes which most commonly produce characteristic clinical manifestations.

Lesions of peripheral nerves may produce thickening, local tenderness, and, rarely, abscess formation. The signs associated with nerve involvement tend to fall into two groups, namely: (1) The *macular*, which is characterized by disturbances of pigmentation, circulation, and sensation in circumscribed areas. (2) The *acroteric*, in which the changes occur in the extremities with a tendency to centripetal spread. These include alterations of sensation; trophic disturbances in the skin, bones, and muscles; and paralyses. The signs of both groups may coexist and either may predominate.

Changes in the skin may be functional, structural, and circulatory. Functional changes are hyperesthesia, hypoesthesia, paresthesia, anæsthesia, hyperhydrosis, anhydrosis. Structural changes are keratosis, hypopigmentation, hyperpigmentation, depilation, atrophy (parchment skin or crushed tissue-paper appearance), infiltration (thickening), suppuration, ulceration

(leprotic, trophic, traumatic), scarring. Circulatory changes are hyperemia, ischemia, œdema (circumscribed or diffused), bullæ.

DEFINITIONS

Leprotic.—It is suggested that the term "leprotic" be applied to those changes which present clinical or microscopic evidence of inflammatory processes, typically of granulomatous nature, which are apparently caused by *Mycobacterium lepræ* in them. In such lesions the organism can usually be demonstrated by the ordinary methods of examination.

Leproma.—The term "leproma" is applied in a general sense to any lesion of a leprotic nature, as defined herein.

Ulcers.—In considering the ulcers of leprosy, distinction is not always made between those which occur in leprotic lesions and from which bacilli are usually discharged, and those which are sequelæ of nerve changes. The former type, occurring in leprotic tissues, should be called "leprotic ulcers." The latter, which usually occur in nonleprotic tissues and do not discharge bacilli, should be called "trophic ulcers." Traumatic ulcers are particularly liable to occur in tissues affected by trophic changes.

Infiltration.—"Infiltration" is a term commonly applied to a diffuse thickening of leprotic nature involving the skin or mucosa which is not of definite nodular, papular, or macular form. The term may also be applied to diffuse leprotic conditions in other organs.

Nodule.—A nodule is a definitely thickened, rounded, circumscribed mass of leprotic nature commonly occurring in the skin, subcutaneous tissue, or mucosa.

Papule.—A papule is a small solid elevation of the skin, of leprotic nature, not more than 5 millimeters in diameter.

Macule.—A macule is a circumscribed area of skin showing changes in color, sometimes with slight elevation or depression. The following descriptive terms may be applied to indicate its peculiar characteristics: Hypopigmented, hyperpigmented, erythematous, circinate, marginate, zonal, raised, atrophic.

3. THE MICROÖRGANISM

Nomenclature.—There is considerable variance in practice in the formal designation of the organism of leprosy. Common practice countenances the informal use of the term "bacillus" for rod-shaped organisms in general. The generic name *Mycobacterium* is now extensively used for the acid-fast group to which the organism of leprosy belongs. Therefore, while it is

permissible to speak colloquially of "the leprosy bacillus," it is recommended that it be not referred to formally as *Bacillus lepræ* (*B. lepræ*), but as *Mycobacterium lepræ* (*M. lepræ*).

"Toxins."—Attention may be drawn to the fact that "toxins" of *M. lepræ*, in the sense used in bacteriology, are hypothetical. It is a striking fact that a patient with extensive and progressive cutaneous lesions containing incalculable numbers of micro-organisms may show no clinical indication of any kind of toxic effect. In the condition known as "lepra reaction" toxic manifestations are seen, but there is reason to believe that these are not due to true bacterial toxins. In the present state of our knowledge it is advisable to avoid the use of this term.

4. CLINICAL CLASSIFICATION OF CASES

The classification of cases of leprosy is an important but difficult matter. Even with the same viewpoint no two workers in leprosy may necessarily classify any large group of patients precisely alike, because of differences of interpretation and of skill and care in examination. Thus, the confusion arising from the present differences of viewpoint and practice makes it imperative that a serious attempt be made to arrive at some uniformity in this matter.

Primary classification; types.—Leprosy is a general disease; in no type are the lesions confined to a single tissue, and the demonstration of bacilli is not always possible by routine methods. All diagnosable cases are in a sense "mixed," and in consequence any classification should be based primarily on the predominating clinical findings.

This Conference is in agreement that cases of leprosy should be divided into two major types, and that these be designated "neural" and "cutaneous." The division is based on the following considerations.

From clinical and pathological evidence it seems clear that the leprosy bacillus has a very special affinity for peripheral nerves. Clinically there are many cases that, for practical purposes, may be considered essentially neural. They frequently have visible (usually hypopigmented) lesions of the skin, but in typical cases the bacteriological findings by the usual methods are consistently negative. However, it is the experience of some observers that in occasional typical cases bacilli may be found in the nasal mucosa, though in their clinical course neural cases differ markedly from those with "leprotic" skin lesions (see page 453). Therefore, regardless of the man-

ner in which the bacillus has entered the body, the mechanism of the production of the skin disturbance, or the possible presence of the bacilli in other tissues such as the lymph nodes, it may be agreed that it is reasonable and useful to recognize a nerve, or "neural," type of leprosy. It is to be realized that neural cases may become "cutaneous" through the subsequent development of leprotic lesions of the superficial tissues.

On the other hand, pure leprosy of the skin does not exist as a type. It may be that in exceptional cases lesions of the skin, in which *M. lepræ* is demonstrable, may exist before lesions develop elsewhere; but there is reason to believe that in such cases the bacillus almost invariably becomes disseminated and causes lesions in other organs, especially the nerves. Furthermore, in many cases that ordinarily would be classed as "cutaneous" leprosy, a history of primary nerve disturbance can be obtained, and very often careful examination may reveal some degree of sensory disturbance and of nerve thickening. Therefore, on this evidence, such cases are strictly "mixed." Sooner or later, in the natural course of the disease, gross evidence of neural involvement (atrophies, mutilations, paralyses) may be expected to develop. Notwithstanding these facts, in order to minimize confusion, it is deemed desirable to class all cases with leprotic lesions of the skin as "cutaneous."

Cases that have once been cutaneous, but with important neural manifestations (that is, the old "mixed"), and have improved until only the neural lesions or sequelæ remain, require separate recognition. If first seen in this condition they would ordinarily be classed as advanced neural, but they should be considered "secondary neural" in contradistinction to the "primary neural" cases, which have never apparently been of the cutaneous type.

PROPOSED CLASSIFICATION OF TYPES OF LEPROSY

A. MAIN TYPES

Neural (*N*).—All cases that show evidence of actual or previous nerve involvement; i. e., alterations of sensation with or without changes in pigmentation and circulation, trophic disturbances or paralyses and their consequent results: atrophies, contractures, ulcerations. These are not accompanied by leprotic changes in the skin.

Cutaneous (*C*).—All cases showing leprotic lesions in the skin. Such cases may or may not show, at any given time, clinical manifestations of nerve involvement.

B. SUBTYPES (INDICATING DEGREE OF SEVERITY)

Neural–1 (N–1).—Slight neural: Cases with one or a few small areas of disturbed sensation, which may or may not show alterations of circulation or pigmentation, paralyses or trophic disturbances of minor degree.

Neural–2 (N–2).—Moderately advanced neural: Cases with extensive or numerous areas of disturbed sensation, not confined to any one part of the body; with paralyses or/and visible evidences of trophic disturbances: marked depigmentation, moderate atrophy, keratosis, bullæ, etc.

Neural–3 (N–3).—Advanced neural: Cases with more or less extensive areas of anæsthesia and marked motor and trophic disturbances; marked paralyses, atrophies, contractures, trophic ulcers, and mutilations.

Cutaneous–1 (C–1).—Slight cutaneous: Cases with one to a few leprotic macules, or a few small areas of infiltration, or nodules.

Cutaneus–2 (C–2).—Moderately advanced cutaneous: Cases with numerous leprotic macules, or fairly numerous or marked areas of infiltration, or nodules, frequently with lesions of the mucosa.

Cutaneous–3 (C–3).—Advanced cutaneous: Numerous or very marked leprotic lesions in various stages of development or retrogression, usually with lesions in the mucosa.

In all cutaneous types there may be varying degrees of neural involvement and such cases should be recorded to indicate the degree of this involvement; as, for example, C–2, N–1.

Secondary neural.—Neural cases that were formerly cutaneous, but from which the active leprotic lesions have disappeared.

5. ADMINISTRATIVE CLASSIFICATION OF CASES

In order to facilitate the application of preventive measures to leprosy, it is desirable to reduce probable sources of infection. To accomplish this it is necessary to recognize that leprosy is probably perpetuated through the implantation of the organism in favorable environment, such as new susceptible hosts. This implantation is believed to be effected through the dissemination of *M. lepræ* from the mucous membrane, skin, and perhaps from the excretions of the infected host. We have no absolute criteria of infectivity, but experience has shown that in cases in which the organism can be found in the skin or mucous membranes it may also be found at times on the surfaces of these.

Such conditions would thus favor its dissemination. Cases from which dissemination seems probable should therefore be classed as "open;" while other cases may be considered "closed." Administrative action concerning the two classes might well differ in its application according to the community affected.

Closed cases were formerly described as "bacteriologically negative;" but since this implied that no bacilli could be obtained from the accessible lesions by the ordinary methods of examination and since the expression might be misinterpreted to mean that there were no bacilli in the tissues, it is recommended that it be replaced by the term "closed" in administrative practice.

6. LEPRA REACTION

Lepra reaction is one of the most interesting and important phases of the disease. It is of frequent occurrence and may vary from a painful neuritis or the reddening of an isolated skin lesion to a general exanthematous eruption or a sudden marked increase in the severity of existing lesions with ulcerations and toxic manifestations, and if protracted may lead to death. Such reactions are frequently referred to as "acute exacerbations" of the disease. This may be misleading. At times lepra reaction may, indeed, initiate an actual advancement of the disease and on subsidence of the acute reaction the original lesions may be larger or more numerous than before. On the other hand lepra reaction may prove beneficial, for after its subsidence the lesions may improve.

This phenomenon and its therapeutic control should be subjected to further study. The whole subject of the value of artificially induced reactions in therapeusis also needs further investigation (see Appendix III).

7. EARLY DIAGNOSIS OF LEPROSY

Special stress is to be laid on the importance of the diagnosis of early and slight cases of leprosy, and of their treatment, both from the point of view of prevention of the disease and of relief of the patient. The sooner a patient is put under treatment the more promising are the results and the less the danger that such a patient will infect others, if the prevailing view that the disease is transmitted from man to man be correct. This view the Conference upholds.

All persons responsible for the diagnosis of leprosy should, therefore, acquaint themselves with the signs and symptoms diagnostic of leprosy in its earliest stages (see Classification of Cases, N–1, and C–1).

8. METHODS OF EXAMINATION

Accuracy of diagnosis and the evaluation of improvement depend upon the methods of clinical and bacteriological examination employed and upon the care and skill with which they are applied.

Clinical.—The use of crude methods as well as careless practice may result in failure to detect cases of slight degree and may also lead to gross errors in estimating the progress of the case. The importance of adopting proper methods of clinical examination cannot be overemphasized (see Appendix I).

Bacteriological.—The significance of the bacteriological findings cannot be considered other than more or less arbitrary. In routine practice the examination is confined to limited portions of the superficial tissues, skin, and nasal mucosa, and even repeated negative findings do not prove that *M. lepræ* is absent therefrom. It can usually be assumed that in neural cases the organisms are present in the nerves at least and that in cutaneous cases they are present also in the deeper organs (see Appendix I).

9. TREATMENT OF LEPROSY

The treatment of leprosy that seems most likely to succeed includes both general and special measures. These measures should be adjusted to the nature of the individual case, and not applied indiscriminately.

General measures.—The general measures that appear to be most applicable do not differ materially from those used in other infectious diseases whose course is often of great chronicity. However, it is believed by physicians experienced in this disease that careful and persistent efforts to eliminate intercurrent affections which tend to reduce the general resistance of the patient are essential to successful therapy. Observations suggest that the adjustment of both the quality and the quantity of the diet may be an important therapeutic measure. It is also the belief of those with experience that other general measures, including personal hygiene, supervised or graduated physical exercise, occupational therapy, the stimulation of morale, and mental welfare are also of definite value.

Special measures.—Special measures include those that may stimulate the general healing processes, and those that attempt to effect the resolution of individual lesions. Such measures include the administration of drugs and the application of physical agents.

The drugs most widely used are oils or their derivatives. The oils in very common use are those of *Hydnocarpus wightiana* and *H. anthelmintica* (chaulmoogra group). The derivatives of these oils that are receiving most attention among clinicians treating leprosy are the ethyl esters of the respective fatty acids and the soaps (sodium salts) of these acids. Available clinical evidence indicates that the therapeutic value of these oils is similar, and this is true also of their derivatives. The choice of these for use in treating leprosy may therefore rest on other factors; such as, the ease with which they may be procured, their cost on delivery, their purity and freshness, and their keeping qualities.

The ethyl esters have been intensively used in large treatment centers and are preferred by the workers in those centers, as well as by others. The preference for this derivative seems to be influenced by the fact that a process of its manufacture has been attained that permits of the repeated production of a stable, uniform, and standardized product; also by the fact that when administered by injection, it produces less local irritation than that caused by some other derivatives. The degree of irritation produced by the injection of the esters may be reduced by the addition of metallic iodine (0.5 per cent) to them (see Appendix IV). However, other workers have preferred to use either the oils, or the sodium salts of their fatty acids. These drugs, also, can be administered by injection, intramuscularly or subcutaneously. They have not been used sufficiently by intradermal injection to admit of comparison with the esters.

The methods of injection may be intramuscular, subcutaneous, intracutaneous, or intravenous. Selection will be influenced to some degree by the nature of the medicament used; for example, it is difficult to inject the oil intradermally, and the esters or a solution of the soap is preferable when this method is used. Attention is called to the fact that oils and esters should not be given intravenously. Recent evidence tends to show that lesions of the skin resolve more rapidly when treated by intradermal injections. The dosage of these various preparations cannot be arbitrarily established, but must be adjusted to the condition of the individual.

Other oils have been used in a manner similar to that adopted with the hydnocarpus group, but experience of their use has not been sufficient to permit of an appraisal of their value.

To stimulate reparative processes in a patient measures have been adopted for the production of a controllable febrile re-

action, not of a specific nature. These measures have included the use of preparations such as foreign proteids, either of bacterial or of other origin, or exposure to physical agents. The physical agents employed for this and for special purposes in the treatment of leprosy include ultra-violet light, radiant heat, hot baths, carbon dioxide snow, fulguration, and diathermy.

Other drugs, especially preparations of gold and other heavy metals, have been advocated for use in special cases, but such drugs should be employed with caution. Iodides have been employed, but they are contraindicated in many cases. Experience has shown that their use should be limited to patients whose general condition is such that they can tolerate full doses of hydnocarpus preparations and maintain at the same time good general health. Adequate control by those skilled in the treatment of the disease is essential.

Standardization and appraisal of treatment.—It is impracticable at this time to establish a standard method of treatment. However, a method that has proved satisfactory is the intradermal injection of preparations of the hydnocarpus (chaulmoogra) group of oils, preferably combined with intramuscular injections (see Appendix II).

It must be recognized that the course of leprosy is often of great chronicity, and final conclusions concerning the therapeutic value of a drug or method cannot be reached until after its use for one to several years. Further, it must be appreciated that there is no accurate method of measuring such therapeutic value. Both clinical estimates and microscopic examinations are subject to many errors. Skill, care, and adequate staff are necessary to carry out these examinations accurately.

Organization of treatment.—This will vary with the number and type of cases to be treated, and with the available personnel and facilities. It will also depend upon the political, geographical, and economic conditions of the community, as well as upon the attitude of the patients and of the general public towards the whole subject. For purposes of treatment, cases may be grouped into classes in accordance with their probable response to treatment and their prognosis regarding arrest or recovery. Under favorable conditions, such classes may be cared for in separate sections of an institution or, preferably, in separate institutions. While certain types and classes of patients may be adequately treated as out-patients, it will be apparent that cases requiring close supervision and those who are incapa-

citated should have institutional care. Under the latter conditions clinical observations can be made more accurately and the patients' regimen can be controlled.

10. EVALUATION OF PROGRESS

In the evaluation of progress it is necessary to use terms to define the stage to which the patient has progressed. Such terms are indicated below. Cases may be classified with regard to the course of the disease as active, quiescent, and arrested.

Active cases.—"Active" cases are those in which there are clinical or microscopic evidences of progressive or of recessive changes in lesions, with or without accompanying systemic disturbances.

These evidences include the following: Positive bacteriological findings in skin or mucous membrane determined by the usual methods; the presence of raised or erythematous lesions; increase or diminution of lesions in size or number; tenderness of nerves, with or without thickening.

Quiescent cases.—"Quiescent" cases are those in which there is no longer clinical or microscopic evidence of activity as defined above.

For the purpose of attaining uniformity of method, the classification "quiescent" should be applied to cases from which the signs of activity have been absent for a period of at least three months. This absence of activity should be determined by at least one examination a month during this period. This examination should include a clinical examination, and also microscopic examinations of the nasal mucosa at more than one site, and of lesions of the skin at more than two sites.

Arrested cases.—"Arrested" cases are those that have remained quiescent for a period of at least two years.

Cure; relative cure; negative.—Use of the term "cure" in relation to the results of the treatment of leprosy is open to misunderstanding; and it is, therefore, recommended that this term should not be employed in the terminology of leprosy. Since the term "negative" is often misinterpreted and the term "quiescent" is more descriptive of progress than "negative," it is recommended that the term "negative" as applied to patients likewise be discontinued. It is further recommended that the term "relatively cured" be not used, since it includes the word "cure;" and that the condition to which it is applied be described by the term "arrested."

11. FOLLOW-UP OF PATIENTS

This Conference considers it desirable to lay emphasis on the need of following up, over a considerable period of years, patients who have apparently recovered under treatment, in order to ascertain the ultimate results thereof. This is important from the scientific and public-health viewpoints, as well as from that of the welfare of the patients. The findings of certain workers who have made a survey of released cases open to question the permanency of the results obtained in recent years. Further knowledge of this matter is greatly needed.

12. STUDY OF CONTACTS

The opinion expressed at the last international conference on leprosy was to the effect that leprosy is a communicable, rather than a congenitally acquired, disease. No satisfactory evidence has been adduced that would invalidate this opinion. Therefore, it is desirable to emphasize the importance of studying the contacts of known and especially of "open" cases. Such work may be difficult and expensive, but the studies should throw important light on the epidemiology of the disease and on its earliest manifestations. It may be that the eradication of leprosy from any given area will depend upon the application of knowledge so gained.

13. STANDARDIZATION OF RECORDS

The Conference strongly indorses the conclusion of the Leprosy Commission of the League of Nations concerning the desirability of attempting to standardize the forms used in recording and reporting leprosy work. It feels that this is of great importance in the comparison of results obtained by different observers, which is almost impossible at the present time.

As the work will entail the collection and detailed study of forms now in use in various active institutions throughout the world and can best be done under the auspices of a permanent organization, the Conference resolves to invite the Leprosy Committee of the League of Nations to undertake this and, after preparing standardized forms, to circulate these to leprologists throughout the world.

III. PROPHYLAXIS

The Conference has not specifically dealt with the subject of prophylaxis in leprosy.

The findings of the Bangkok meeting (1930) of the Leprosy Commission of the League of Nations, which have not yet been released for publication, were placed before it.

The Conference gives its approval to these findings in principle.

IV. RESEARCH

While there are many facts regarding leprosy that may not be known even after intensive and prolonged research, there are others that require prompt investigation because of their immediate importance in more effective control of the disease. A recent survey made by the Leprosy Commission of the League of Nations has also shown that there is lack of coördination in the research now in progress. The following program of subjects, which seem to be in urgent need of investigation, is therefore submitted.

1. EPIDEMIOLOGY

It is believed that studies in the epidemiology of leprosy are greatly needed. There are serious defects in our knowledge of the incidence with regard to race, geography, environment, occupation, climate, family history, age, sex, and diet; also the incubation, duration, apparent spontaneous disappearance, incidence among healthy attendants in leprosaria, spread in newly invaded areas, apparent immunity in certain districts or areas as compared with others, etc.

Comparison of observations made over widely scattered areas is highly desirable. In order that the data collected in such observations may be of the greatest value, they should be as complete as possible, systematic, and made by units of trained personnel. An outline that includes most of the details considered essential to accomplish this is appended (see Appendix V).

However, much can probably be learned from surveys that cannot be made in so intensive a manner, and it is suggested that these should include as many of the outlined data as may be feasible.

Any survey might well include inquiries into native folklore, traditions, and superstitions regarding the disease.

2. CLINICAL STUDIES AND THERAPEUTIC EXPERIMENTATION

The clinical course of the disease has been studied, for the most part, in cases that are now classified as of moderate or marked advancement. It is of great importance that studies be made for the purpose of detecting the disease in its earliest stages. The clinical observations in such cases should be supplemented by the development of technical procedures which may be applied to the patient or executed in the laboratory. Investigations should be made of individuals who may not have shown clinical evidence of the disease and of those who have apparently recovered. Such investigations might be regarded as those of latent leprosy, and may include various cutaneous tests or cuti-reactions with specific vaccines, and the determination of the persistence of *M. lepræ* in the nasal mucosa.

The clinical phenomenon known as "lepra reaction" is worthy of particular attention, because of its frequent occurrence in the course, and because of its apparent alteration of the course of the disease. Its causes, nature, and control are still undetermined.

Investigations of clinical phenomena should be intimately correlated with the effect of therapeutic measures on the patient. This is especially pertinent, because of the failure to produce in animals conditions that closely resemble human leprosy. The interpretation of pharmacological investigations in animals should be considered with regard to their probable effect in man. Some remedies may produce marked disturbances in the course of the disease, and their use may be dangerous in certain stages, while in others they may be beneficial. The use of iodides, especially potassium iodide, should be studied in this connection. Their employment, however, should be attended with extreme caution; and it has been suggested that the indication for their administration may be determined and controlled by the application of the red-blood-cell sedimentation tests. Various remedies for certain phases of the disease should be explored, such are exemplified by the use of tetradotoxin and dilo oil (*Calophyllum bingator*) in lepra reaction. There is also further need for carefully controlled tests and more accurate appraisal of the special remedies now commonly used, and for those of physical therapy; such as, electrotherapy, mechanotherapy, hydrotherapy, actinotherapy, and physiological exercise.

3. DIET

Differences have been noted in the incidence of leprosy in the people of various regions in India, Korea, China, and other countries, which suggest that intensive studies of the diet of the people are desirable. These studies should include the foods in use, the methods of preparation, the degree of preservation (freshness, decomposition), the quantity (famines), and the quality (vitamins, inorganic salts). The effect of diet in general therapy is also of importance.

4. ETIOLOGY AND PATHOGENESIS

The entire subject of the pathogenesis of leprosy is in need of investigation, and this should comprise studies of *M. lepræ*, including the possibility of its growth in cultures of tissue; its chemical and biological relationship to other bacteria of the acid-fast staining group; and its behavior in animals when inoculated from suspensions made from lesions, but freed of tissue. Efforts should be continued towards finding an animal susceptible to inoculation (anthropoid apes); the preferable site of inoculation; the effect of massive doses of the inoculum; and repeated inoculations. Animal diseases that resemble leprosy (rat leprosy) may also afford a fruitful field.

Research is urgently needed concerning the site and manner in which the organism invades the body; its dissemination through the tissues and its seeming selectivity for certain tissues and sites in them; and the pathological changes produced by it in the first or early clinical lesions, in leprides, in the nerves throughout their course, and in the bones and blood vessels as well as in the skin. The pathology of the tissues of the patient who has been treated should be investigated.

These studies should also include those of immunity, and should embrace serological and cytological studies (lepra cells), allergy, and the relation of vaccines of *M. lepræ* and other acid-fast organisms. (Tubercle bacillus B.C.G.)

5. BIOCHEMISTRY

Experience with leprosy suggests that the metabolism of the case of leprosy is deranged, and it is also thought that the type of the food consumed by the patient may alter his suceptibility to the disease. It is evident, therefore, that biochemical studies

are needed in this regard in metabolism, vitamins, inorganic salts, proteids, carbohydrates, and fats. Knowledge of chemistry of the blood (lipoidal content) may also be of great value in interpreting various phases of the course of the disease.

6. PHARMACOLOGY

The pharmacological action of remedies (for example, metals) applied to this disease may be different from that in others; and it is, therefore, necessary to investigate the special action of drugs that have been used and to develop others, which may be of greater value. Such studies may well be made of the action of the drugs now in use on *M. lepræ*, the action of the various preparations of the hydnocarpus group (and of other oils), native remedies, synthetic remedies, new remedies, the selective action of drugs, and the relation of the secretions of the endocrine glands.

APPENDICES

I. DETAILS OF EXAMINATION

(*a*) *Clinical examination.*—The whole body should be examined, in so far as is possible, in a good light and all the findings accurately recorded. While many auxiliary tests may be employed, the following methods are important:

1. Sensation to light touch.—The patient should be blindfolded. The normal skin should be repeatedly touched with some light object, such as a cotton swab, a feather, a camel's-hair brush, or a spill of paper, and the patient asked to indicate accurately with the point of the finger the place touched. When the patient is responding to these stimuli, the suspected skin areas should then be similarly tested, loss of sensation to light touch being indicated by repeated failure to respond. In this way anæsthetic areas may be gradually mapped out.

2. Sensation to pain.—The eyes being blindfolded, a suspected skin area is alternately touched with the head of a pin and pricked with the point, a corresponding normal area being similarly examined immediately afterwards. The patient is questioned as to which prick produces more pain, the touch with the head or the prick with the point. This process should be repeated several times so as to avoid error.

3. Sensation to heat and cold.—This may conveniently be tested under similar conditions by touching suspected areas with two test tubes alternately, the one containing hot (40 to 50° C.)

and the other cold water (20° C. or lower), the patient being asked to distinguish between them.

4. Thickening of the skin.—The detection of slight degrees of skin thickening often requires considerable care. Inspection, with or without a magnifying glass, should be supplemented by palpation, the suspected area being rolled between the finger and thumb. Comparison should be made with the surrounding skin and with the corresponding area on the other side of the body.

5. Thickening and/or tenderness of the nerves.—The superficial nerve trunks in normal individuals are frequently palpable and firm pressure may elicit slight pain. The determination of thickening and abnormal tenderness should depend on careful comparison with the nerve, if unaffected, on the other side of the body or with the corresponding nerve in a healthy person of similar build. The superficial nerve trunks most commonly affected are the ulnar, the superficial peroneal, and the great auricular. Sensory branches supplying macules are sometimes tender and palpably thickened.

6. Mucous membranes.—In examining the nasal mucosa it is advisable to use a speculum, and the field should be well illuminated.

(b) Bacteriological examination.—Particular stress is to be laid on the need of examining smears from several sites and of making repeated examinations. Organisms may be demonstrable in one lesion or in only one part of it, while in another lesion they cannot be detected. In the early progressing cutaneous case the organisms in a lesion may be few and scattered, later becoming more numerous and generalized, while the converse may be true in the case as it improves.

Smears should contain as little diluting material (blood, lymph) as possible, but the specimen should be so taken as to contain cellular material from the deeper layer in which the organisms are normally to be found.

1. Skin examination.—There are two principal methods of procuring material for examination; namely, the "scraping" and the "snip." By the former a very small cut, about 2 millimeters deep, is made with the scalpel well into the dermis, and material is scraped from the depth of this and smeared on a slide. By the latter method a small portion of the dermis, at least 2 millimeters thick, is snipped off with a sharp pair of scissors, curved on the flat. The raw surface of the tissue so obtained

is applied to a slide and firm pressure is exerted so as to express as much as possible of the cellular elements.

2. Nasal examination.—With the use of a nasal speculum the interior of both nares is carefully examined for infiltrations, nodules, and ulcers. If any of these is found, material should be removed therefrom with a blunt narrow-bladed scalpel, or a similar instrument, by scraping deep enough to cause slight bleeding. Even when there is no visible lesion, a scraping should be taken from the septum. *Mycobacterium lepræ* may be found on the septum, the inferior and middle turbinates, or the floor of the nose. The material so obtained should be smeared on a slide.

3. Staining.—After drying, and fixing over a flame, smears are stained for at least ten minutes at room temperature or heated three minutes till steam rises, in a solution of carbol fuchsin. This is prepared by mixing one part of a 10 per cent solution of basic fuchsin in 90 per cent alcohol with nine parts of a 5 per cent solution of carbolic acid crystals in distilled water. This solution should be prepared at frequent intervals and be discarded when there is any trace of precipitate.

The slide is decolorized with sulphuric acid (10 per cent) or nitric acid (10 to 20 per cent) in water, and counterstained with methylene blue.

II. METHOD OF TREATMENT BY INTRADERMAL INJECTION

A scheme of treatment in use at some of the largest centers is as follows:

The ethyl esters of hydnocarpus oil, which are prepared in accordance with the methods outlined on page 471, are preferred, but a stable uniform preparation of the sodium soaps of the fatty acids of the oils of this group may be used.

The injections may be given at weekly intervals. Not more than 5 cubic centimeters are given to a patient at any one time, and not more than 0.1 cubic centimeter is injected at any one point in a lesion. Whenever feasible, the lesion to be injected is completely infiltrated by producing coalescing "injection wheals." If the lesions are so small or so few that 5 cubic centimeters cannot be injected into them, the balance is given intramuscularly. The combination of the intramuscular and intradermal administration in each patient seems desirable. The frequency of injections of any one lesion is limited by the local inflammatory reaction.

III. TREATMENT OF LEPRA REACTION

The following methods have been used in controlling lepra reaction.

(*a*) The patient should be put at rest, and if there is no contraindication, a sharp purgative is given, means being taken thereafter to keep the bowels well regulated.

(*b*) A light but well-balanced, nutritious diet should be given.

(*c*) Accompanying diseases should be searched for and treated. The presence of such diseases, though often obscure, may stimulate a lepra reaction.

(*d*) Potassium antimony tartrate given every second day intravenously in doses of 0.02 to 0.04 gram has been found useful.

(*e*) Calcium chloride (20 cubic centimeters of a 5 per cent solution) may be given intravenously.

(*f*) Calcium lactate, 1 to 2 grams daily in divided doses, and sufficient sodium bicarbonate may be given to make and maintain an alkaline reaction in the urine.

(*g*) Lepra reaction may be accompanied by a very painful neuritis, which may lead to rapid atrophic changes in the parts supplied by the affected nerves. Rapid relief of pain may be afforded by the intramuscular injection of adrenaline (0.3 cubic centimeter of a 1,000 solution) diluted in saline, or by the administration orally of 0.05 gram of ephedrine sulphate. The effect of the latter drug is more lasting than that of the former. Instantaneous relief has also been obtained by the injection around a subcutaneous nerve trunk of 10 cubic centimeters of 0.05 gram of ephedrine sulphate dissolved in saline.

In giving special antileprosy treatment care should be taken not to exceed the tolerance of the patient, otherwise lepra reaction may result. Such special treatment should always be discontinued during lepra reaction and until the patient has completely recovered therefrom.

IV. MANUFACTURE OF MIXED ETHYL ESTERS OF HYDNOCARPUS-GROUP OILS

Preparation of esters by hot process.—Ten liters of hydnocarpus oil are boiled vigorously for forty-eight hours with 5 liters of 96 per cent ethyl alcohol and 100 cubic centimeters of concentrated sulphuric acid under a reflux condenser. The principal advantage of vigorous boiling is undoubtedly that it keeps the two layers well mixed. The esters are then separated from the lower layer, from which the excess alcohol can be recovered

by distillation. The esters are washed three times with about 20 liters of water, separated from the washing water, and dried in a steam kettle or on a water bath. The yield from 10 liters of oil is about 11 liters of esters. Proportionally smaller amounts of materials may be used to prepare smaller lots of esters.

Distillation.—The washed and dried ethyl esters are then distilled at 20 to 25 millimeters pressure in a glass or iron still.

Washing with alkali.—Before neutralizing the esters, the acidity is determined by titration. Five hundred grams of lye (94 per cent sodium hydrate) are dissolved in 80 liters of hot water (90° C.) in a 160-liter steel drum. Forty-five liters of the distilled ethyl esters (2.5 to 3 per cent acidity) are added and thoroughly mixed. If the acidity is higher than 3 per cent a correspondingly increased amount of lye is added. After the mixture has stood for twenty-four hours the clear lower layer is drawn off through an outlet in the bottom of the tank. Hot water (90° C.) is added to the 140-liter mark, thoroughly mixed, allowed to settle for twenty-four hours, and again drawn off. The washing with water is repeated four times, and each time twenty-four hours are allowed for settling. The yield is about 96 per cent, and the acidity (as oleic acid) is usually under 0.1 per cent. If smaller lots of esters are to be neutralized it may be found necessary to add crystals of sodium chloride to assist the separation. Heating on a boiling-water bath will also hasten the process.

Steaming and drying.—Volatile impurities, which are often irritating, may be eliminated by blowing out with steam. About 15 liters of the washed esters are put in a 26-liter stoneware carboy and steam is passed through the liquid for two hours or longer, until the pungent odor has disappeared from the condensed steam. The esters are placed in ordinary 5-gallon oil tins to settle, poured off from the separated water, and filtered through paper. The product is a clear, very pale yellow, mobile liquid with a slight, characteristic odor. Smaller quantities of esters may be refined by this method.

Ethyl esters manufactured by the above process are of constant composition and relatively nonirritating, regardless of the source or quality of the original oil.

Preparation of esters by cold process.—Four hundred twenty-five grams of cold-drawn hydnocarpus oil of good quality, 550 cubic centimeters of 96 per cent ethyl alcohol, and 32 cubic centimeters of sulphuric acid (sp. gr. 1.845) are placed in a bottle

with a tight-fitting glass stopper and left until the process of esterification is complete. The bottle should be shaken once or twice a day to mix the upper and lower layers. This, or placing the bottle in the sun or in some warm place, hastens the process. Neither shaking nor heat is, however, essential if time is not a consideration. At first the oil forms a lower and the alcohol and acid an upper layer. As esterification proceeds a point is reached at which the lower layer, now chiefly composed of esters, is of lower specific gravity than, and rises above, the original upper layer, which now contains a large proportion of glycerol. To ensure the completion of esterification it is well to allow the process to continue for a further period equal to the time required for the rising of the lower layer. Thus, if the lower layer takes fourteen days to rise, the ingredients should be left in the bottle for another fourteen days. When the upper layer dissolves completely in alcohol the esterification is complete; esters, but not oil, being completely soluble in alcohol. The lower layer is then drawn off and the upper layer repeatedly washed with an equal volume of water until the water is free from acid as tested by litmus paper. A 0.1 per cent solution of sodium hydrate in water is then added; this forms a thick emulsion. The vessel is slowly rotated and crystals of common salt are gradually added in small quantities in order to break the emulsion. The lower layer is removed; and the upper layer consisting of esters, after being washed once more with distilled water, is filtered through thick filter paper. The esters, though now clear, still contain a certain amount of fine emulsion which makes them dark in color. This may be removed by drying on a water bath for two or three hours while stirring constantly with a glass rod. The esters are then filtered again and the process is complete.

The esters may be washed in the bottle in which they have been prepared by substituting for the glass stopper a perforated cork with two glass tubes; one, 2 inches in length, is inserted flush with the inner end of the cork and fitted with a piece of rubber tubing compressed with a spring clamp; the other reaches to the bottom of the bottle. By inverting the bottle the esters rise to the top and the lower layer may be drained off by opening the clamp; or the lower layer may be syphoned off through the long glass tube without inverting the bottle. A separating funnel is more convenient for separating and washing the esters.

Preparation of ethyl esters by hot process without distillation.—The esters may be much more rapidly prepared by placing the ingredients mentioned under the cold process in a flask

on a water bath arranged to maintain a constant level of water. A reflux condenser is connected with the flask. The water bath is kept at a temperature sufficient to maintain brisk boiling inside the flask. This is continued without stopping for eighteen hours, when it will be found that esterification is complete. Washing of the esters is then carried out as described in the cold process. The weight of the esters recovered is almost equal to that of the oil used.

In order to produce nonirritating ethyl esters by the last two processes, the original oil must be nonirritating.

Addition of iodine.—Addition of metallic iodine (0.5 per cent) to the ethyl esters markedly reduces the irritating quality of the ethyl esters. Fifteen liters of the purified esters are heated in a 20-liter enameled kettle to 140° C. The esters must be thoroughly dried before iodine is added since, if water is present, it effects by catalysis the hydrolysis of several per cent of the esters. If the filtered esters are clear, the heating to 140° C. before adding the iodine will drive off all dissolved water. Seventy-five grams of chemically pure resublimed iodine are added with stirring. The temperature immediately rises to 150° C., at which point it is maintained for exactly thirty minutes, the liquid being stirred occasionally. After cooling, the iodized esters are filtered into bottles (250 cubic centimeters capacity) and sterilized for one hour in an oven at 150° C. The temperature of the contents of the bottles reaches in this time 110° C. The bottles are tightly corked, and sealed with paraffin or sealing wax and allowed to stand two weeks before use.

Note 1.—Smaller lots of esters can be iodized by this method provided that a shallow (pan) type of container is used.

Note 2.—It is not advisable to use esters after the lapse of two years, although samples that have stood longer than three years do not seem to have deteriorated sufficiently to become markedly irritating.

Note 3.—Iodized esters must be kept tightly corked and preferably in a dark, cool place. Repeated resterilization should be avoided. Heat or sunlight in the presence of air produces a change in the iodized esters, which increases their irritating qualities to a marked extent.

Refining of hydnocarpus-group oils.—Crude hydnocarpus oils are sometimes found to give pain upon injection. A bland, nonirritating oil may be produced by the following method of refining.

Volatile impurities can be removed by passing steam through the oil for about an hour, either before or after washing with alkali. Sufficient steam is used to give an aqueous distillate of about one-fifth the volume of the oil. The amount of volatile impurities is very small, but the distillate has a strong odor.

The free fatty acids are removed by washing with a solution of caustic alkali, and the only difficulty is the separation of the pure oil from the resulting emulsion. The following method has proven satisfactory. One hundred fifty liters of hot water (about 90° C.) are run into a 400-liter steel drum provided with a faucet at the bottom; 0.5 kilogram of lye (94 per cent sodium hydrate) is added, followed by 100 liters of hydnocarpus oil (not over 2.5 per cent acidity), and thoroughly mixed. With oil of higer acidity a correspondingly increased amount of lye must be used.

After the emulsion has stood twenty-four hours the clear lower layer (about 125 liters) is drawn off. Hot water is run in, while stirring, up to the 350-liter mark.

After two days the slightly opalescent lower layer (200 liters) is drawn off. The washing with water is repeated four times, and twenty-four hours are allowed for separation on each occasion.

Ninety-five liters of oil are obtained, with an acidity of not over 0.2 per cent. This oil is steamed as described above and filtered, while hot, through folded filter papers. The filtrate is dried by heating in an enamel-ware kettle, filtered again, and sterilized in bottles at 150° C.

Some provision must be made for keeping the oil hot during the separation of the emulsion if smaller quantities are refined, otherwise the mixture cools too rapidly to allow separation to take place.

V. EPIDEMIOLOGICAL SURVEYS

The data that should be included in an epidemiological survey are given below in tabular form.

OUTLINE OF DATA TO BE OBTAINED

1. Community. Name and type (village, town, district, country, etc.).
   - A. Geography. Location; topography; geology (soils, etc.).
   - B. Climatology. Temperature (maximum, minimum, mean); humidity (relative, absolute); rainfall (minimum, maximum, mean, seasonal); winds (velocity, prevailing, hurricanes, typhoons, etc.).

C. Population. Total number and variation in numbers; censuses or estimates; migrations; number of families.
   1. Racial. Numbers of each; types of each (aborigines, natives, recent immigrants); mixtures (numbers and types).
   2. Social. Religions, castes, etc.; numbers of each, types of each; marriage laws, food laws, etc.; housing: types and sanitary surroundings.

D. Occupation. Industrial; agriculture (crops, amounts and types); tenant system (serfdom, overcrowding, communal system, family or larger units); husbandry; fisheries.

E. Diseases (general, not leprosy). Prevailing types, incidence of these and frequency of epidemics; endemicity; diseases probably due to faulty diets, type of diseases and prevalence.

F. Leprosy. Incidence; distribution (geographically and by house within the community; note any unusual prevalence along lines of communication or in other districts).

G. School survey. Children; number of children from 1 to 4 years of age (inclusive); number of children of school age; number attending school; number of cases of leprosy in these groups.

2. Family.

A. Blood relations. Name of head of family; number in the family; age of members, sex of members; race; number, age and sex of breadwinners; age of individuals and total for family.

B. Household family. Same data as for A.

C. Diseases. History of diseases other than leprosy in the family, including those prevailing in previous generation. Prevalence of disease in the habitation. Sanitary surroundings of houses.

3. Individual leprosy case.

Name; age; sex; occupation (indicate the type of the labor performed); age; economic status; marital state; race; caste; class; religion; education.

Dietary; foods and proportions of these used; manner of preparation (freshness of food).

Diseases other than leprosy; history, prevalence, etc.; estimate of state of general health.

Leprosy; examine for the following; type (neural or cutaneous and degree of these); probable infectivity; source of infection; history of case; history of previous cases in the family, in relatives and previous generations; contacts, including previous cases in the family or household, as well as casual contacts.

THE INTERNATIONAL LEPROSY ASSOCIATION

It was realized that this Conference afforded an exceptional opportunity to consider the question of a permanent international organization of those engaged in activities concerning leprosy and of others interested in such work. It has long been felt that such a body would serve a useful purpose in stimulating greater interest in the problem and in efforts to obtain more effective results.

Accordingly, information was laid before the Conference concerning two movements to this end. These were (1) a discussion begun in 1922–23 among certain leprologists, which resulted in a decision to organize a society as soon as there should seem to be a possibility of obtaining funds to support a periodical; and (2) a separate movement started in 1925–26 to form an organization to be called "Société Internationale de Leprologie." The latter has unfortunately not become active. The Conference was also advised that the Leonard Wood Memorial for the Eradication of Leprosy would consider sympathetically a request for a subsidy to aid such a plan as the Conference might indorse.

After a thorough discussion of the matter it was unanimously decided that the existing circumstances made it advisable to inaugurate a movement in which due consideration should be given the plans of those previously interested in the matter and every effort made to secure their coöperation. A proposed constitution and by-laws, comprising features of the earlier plans, were studied by the Conference. Upon reaching agreement on these, the members of the Conference joined unanimously in forming the Association. A meeting of the Association was then held; the constitution and by-laws, subject to modification when organization of the Association has been completed, were adopted, and temporary officers were elected.

The name of the organization is THE INTERNATIONAL LEPROSY ASSOCIATION (Association Internationale de la Lèpre).

The purposes are: "To encourage and facilitate mutual acquaintance and collaboration between persons of all nationalities concerned in leprosy work and the coördination of their efforts; to facilitate the dissemination of knowledge of leprosy and its control; and in any other practicable manner to aid in the anti-leprosy campaign throughout the world; and to this end to publish a scientific journal of leprosy. It shall endeavor to coöperate with any other institution or organization dealing with leprosy work."

For purposes of expediency provision is made for a Western Section and an Eastern Section; a General Council to be in charge of the general affairs of the association, and Section Councils to be in charge of sectional affairs.

Membership may be of two classes. "Regular membership" is open to all persons with recognized medical or other scientific qualifications, who are actively engaged in connection with the study, treatment, or control of leprosy, or who have been so

engaged. "Associate membership" is open to all other persons connected with or especially interested in leprosy.

The chief activities anticipated are those of the holding of meetings and the publishing of a scientific periodical on leprosy. When found desirable and practicable, it is intended that general leprosy congresses shall be convened. It is believed that the sections can hold meetings more frequently, possibly in connection with other medical gatherings.

The proposed periodical, to be called THE INTERNATIONAL JOURNAL OF LEPROSY, will contain, besides suitable original articles, reprintings of important papers that have appeared elsewhere, abstracts, news items, and possibly correspondence and other appropriate material. The editorial control of the Journal will be carried out by a board consisting of an Editor and two Associate Editors, to be chosen by the General Council.

It was agreed that, for some time, it would probably be impossible to finance a satisfactory journal solely from membership fees and subscriptions. Since there was reason to believe that the Leonard Wood Memorial would consider sympathetically a request for a subsidy for this purpose, a resolution was passed requesting such aid for a period of five years. If this is granted, it is intended that publication will commence early in 1932.

The temporary general council elected is: President, Dr. Victor G. Heiser; Vice President, Western Section, Prof. Carlos Chagas; Vice President, Eastern Section, Dr. E. Muir; Secretary, Dr. R. G. Cochrane; Treasurer, Dr. Wm. H. Brown; General Councillors, Prof. Nagayo, Sir Leonard Rogers, Dr. Etienne Burnet, and Prof. de Langen. The council made the following appointments: Editor (and general councillor *ex officio*), Dr. H. W. Wade; Associate Editors, Dr. H. P. Lie and Dr. James L. Maxwell. Elections and appointments of persons not at the meeting are subject to their acceptance.

The temporary council was charged with the duty of enrolling additional members. Upon the attainment of an adequate membership, it will conduct an election of the regular officers through the post; and shall organize the Sections. It is believed that this can be accomplished within a year. Applications for copies of the constitution and by-laws or other information should be addressed to the Secretary, International Leprosy Association, 29 Dorset Square, London, NW. 1, England.

RESOLUTIONS

RESOLUTION I

Requesting from the Leonard Wood Memorial for the Eradication of Leprosy aid to the International Leprosy Association for the publication of a Journal of Leprosy.

(Adopted, session of January 21, 1931.)

"WHEREAS, the Leonard Wood Memorial Conference on Leprosy, believing it to be of the greatest importance that leprologists and others interested in leprosy be organized and that a scientific journal of leprosy be published, has organized an International Leprosy Association, one of the primary purposes of which shall be to publish an International Journal of Leprosy, and,

"WHEREAS, it is estimated that such a Journal, of satisfactory quality, can be published at a cost of from $5,000 to $6,000 gold a year, but it is recognized that sufficient funds cannot be raised for the purpose previous to publication and that it is uncertain whether for the first few years income (membership fees, subscriptions, advertising) will equal the cost of publication; *Be it*

"RESOLVED, That the Leonard Wood Memorial for the Eradication of Leprosy be approached to grant to the International Leprosy Association a subsidy for five years, the amount to be, for the first year $5,000 gold and for the next four years the amount required to cover the difference between income and cost of publication but not to exceed $5,000 in any one year."

RESOLUTION II

Bringing the suggestion to the notice of The Leonard Wood Memorial for favorable consideration the publication and distribution of a booklet containing plans, photographs, and suitable text of the leprosarium and skin dispensary at Cebu, Philippine Islands.

(Adopted, session of January 21, 1931.)

"This Conference, being convinced of the value of early publication and general distribution to leprosy workers of a booklet containing plans, photographs, and suitable text of the new leprosarium and skin dispensary at Cebu, wishes to take this opportunity of bringing this suggestion to the notice of the Leonard

Wood Memorial for favorable consideration as an activity in the leprosy field which it might find it possible to undertake at an early date."

RESOLUTION III

Indorsing the note on prophylaxis prepared by the Leprosy Commission of the League of Nations at its meeting at Bangkok in December, 1930.

(Adopted, session of January 21, 1931.)

"This Conference has had the opportunity to examine the note on prophylaxis of the Leprosy Commission of the League of Nations prepared at its meeting at Bangkok in December, 1930.

"After consideration thereof, this Conference endorses this report in principle."

RESOLUTION IV

Conveying appreciation of members of Conference to the Board of Directors of the Leonard Wood Memorial for the Eradication of Leprosy, etc.

(Adopted, session of January 21, 1931.)

"This Conference wishes to place on record its high sense of appreciation of the generosity of the Board of Directors of the Leonard Wood Memorial for the Eradication of Leprosy in enabling such a conference to be held in such a highly organized center of antileprosy work as the Philippine Islands.

"The Conference would further desire to record its appreciation of the foresight and action of the Board of Directors of the Leonard Wood Memorial in assembling a representative body of those interested in the treatment of this disease.

"The Conference feels that the results of its deliberations are likely to provide necessary stimulus to the movement for the control and eradication of leprosy with which the Leonard Wood Memorial is so closely identified.

"The Conference wishes further to express its gratitude to the Leonard Wood Memorial for its sympathetic attitude to certain proposals which may require further financial consideration."

The Conference also passed a resolution expressing its grief at the early death of Dr. Eloy V. Pineda, of the leprosy staff of the Philippine Health Service; and a further resolution of appreciation to Mr. Perry Burgess for organizing the Conference and the part he played in its functioning.

ERRATA

Page 253–270, disregard all figure references to plates except those included under "Illustrations" on page 271.

Page 253, in line 16, *for* (1925) *read* (1915).

Page 273, in lines 26 and 27, *for Euparyphium ilocanum= Echinostoma ilocanum* (Garrison, 1908), *read Euparyphium ilocanum* [=*Echinostoma ilocanum* (Garrison, 1908)].

Page 282, in lines 13 and 14, *for Euparyphium ilocanum, Echinostoma ilocanum* (Garrison, 1908), *read Euparyphium ilocanum* [=*Echinostoma ilocanum* (Garrison, 1908)].

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[New names and new combinations are printed in **boldface.**]

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